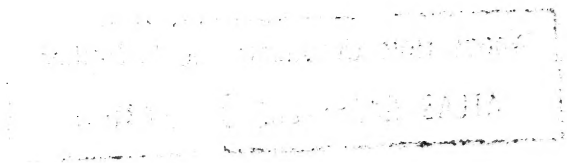
H. O. PUB. NO. 609

A FUNCTIONAL GLOSSARY OF ICE TERMINOLOGY

U. S. NAVY HYDROGRAPHIC OFFICE
WASHINGTON, D. C.



FRONTISPIECE

Land ice and **sea ice.** In the background a **valley glacier** with **lateral** and **medial moraines** terminates in a **fiord** which is covered with **sea ice. Icebergs** calved from the **glacier** are frozen into the **sea ice. Puddles** of melt water have formed on the **sea ice** surface and run together to form an extensive network. The continuity of the **sea ice** cover is interrupted by a **lead** across the mouth of the **fiord** and by **shore leads** along the shore line. A small **ice tongue** at the left has too little erosive power to reach sea level. In the center along the shore there are three or four **talus** slopes.

H. O. PUB. NO. 609

A FUNCTIONAL GLOSSARY OF ICE TERMINOLOGY

PUBLISHED UNDER THE AUTHORITY OF THE SECRETARY OF THE NAVY

U. S. NAVY HYDROGRAPHIC OFFICE
WASHINGTON, D. C.
1952

For sale by the U. S. Navy Hydrographic Office, Washington 25, D. C., Price 80c

This work was begun by the Hydrographic Office but was brought to completion through the assistance of the Office of Naval Research, as a part of Project NR 083032.

PREFACE

This publication is an extension of H. O. Study No. 103, "A Functional Glossary of Ice Terminology," which was compiled hastily for use by various parties operating in the arctic during the summer of 1948. Originally the glossary was confined chiefly to arctic sea ice, but additional land ice definitions are now considered desirable. The latter follow very closely a classification established by Wright and Priestley. Also, equal emphasis has now been placed on antarctic terms for the sake of comparison, usefulness, and completeness. As a result of field testing of H. O. Study No. 103, the glossary has been revised, enlarged, illustrated, and printed in its present form.

The purpose of the present glossary is threefold: (1) To standardize ice terminology and its usage, (2) to provide a convenient means by which ice may be classified and described, and (3) to develop a better understanding of ice properties in general. To help in achieving these ends, a key for classifying ice features has been inserted before the alphabetical listing of ice terms and their definitions. This publication has been designed to be used either as a reference for definitions of ice terms or for study of ice features.

In compiling this glossary the major sources of English terminology have been consulted and foreign words have been held to a minimum. Foreign words have not been used where an English equivalent term in general use exists. In case English (or British) usage differs from the American-Canadian, the latter has been preferred. An attempt has been made to eliminate ambiguous terms and to restrict meanings to the best accepted usage.

Emphasis has been placed on ice terms as such, and most of those dealing with depositional features, such as continental glaciation, have been omitted. However, a few features closely associated with ice, which may be observed from aircraft or shipboard, have been included. Only a few terms have been included in this glossary pertaining to permafrost, which has its own extensive and growing terminology.

Snow and snow surfaces, while of major importance to the skier, mountaineer, polar explorer, and flier, are outside the scope of this glossary. These subjects have been treated comprehensively and illustrated well by G. Seligman in his "Snow Structure and Ski Fields."

In the preparation of this glossary, previous discussions of the subject have been freely drawn upon, the principal sources being listed in the bibliography. There have also been included data derived from observations in the polar regions by personnel of this office and their associates. An effort has been made to incorporate the latest results of polar research and exploration, as evidenced by the dates of the items in the bibliography,

as well as latest information supplied by recent military operations in the arctic and antarctic.

The illustrations are from a variety of sources and wherever possible are new. Unless otherwise stated, the illustrations are taken from official U. S. Navy photographs. Good pictures are not easily obtained in polar regions because of the prevailing poor visibility, abundance of fog and clouds, low elevation of the sun, and inaccessibility of the subject, combined with the usual inexperience of the photographer with high latitude lighting conditions.

Acknowledgment for aid and photographs is made to: Dr. C. A. Barnes, University of Washington; Major A. R. Gordon, Jr., USAF; E. C. LaFond, U. S. Navy Electronics Laboratory; J. H. Roscoe, Directorate of Intelligence, USAF; H. B. Washburn, Jr., Boston Museum of Science; and J. F. Holmes, W. G. Metcalf, and M. J. Pollak, of Woods Hole Oceanographic Institution.

Acknowledgment is also made to the following sources for permitting the use of copyrighted illustrations:

International News Photos, New York City (Fig. 102);

J. B. Lippincott Co., Philadelphia, from "The Home of the Blizzard" by Sir Douglas Mawson (Figs. 80, 81, 84);

Betty Love, Springfield, Mo., (Fig. 108); and

Scott Polar Research Institute, Cambridge, England (21 illustrations taken from Wright and Priestley).

Because of the limited period that any one observer will usually spend in the polar regions, it is important that his preparation for what he may see be in the nature of pre-experience. It is hoped that this publication will provide much of this pre-experience and that all official ice observers will acquire a thorough grasp of the material in this glossary before leaving for the arctic or antarctic.

TABLE OF CONTENTS

LIST OF ILLUSTRATIONS

955934O—52—2.

GUIDE TO THE KEY AND THE ICE GLOSSARY

To make an intelligent approach toward an understanding of ice, it is necessary to know first which ice features can and should be observed. Obviously some order or system is required so that thinking can be uncluttered and properly directed. The following key is a collection of the more significant ice terms assembled into homogeneous, convenient groups. A portion of the glossary is built around each group. The key is no mere assemblage of ice terms, but rather a framework or nucleus devised for building eventually a complete ice terminology with provision for ice elements and ice processes as yet undiscovered.

The key has five large divisions: **Sea Ice, Land Ice, Lake Ice, River Ice,** and Special Terms. The large divisions are then subdivided as, for example, **Sea Ice** into **Floating Ice, Fast Ice,** and Related Features. Each of these is likewise further subdivided. Thus, **Floating Ice** is described according to its **Concentration, Size, Age,** and **Topography.** Finally these latter categories are broken down into elemental groups as, for example, **Concentration** into **Open Water, Scattered Ice, Broken Ice, Close Ice, Consolidated Ice,** and Transitional States.

The key can be considered a basic vocabulary of the more important, preferred ice terms which are defined and elaborated upon in the body of the glossary. These particular terms have been selected as focal points around which the groups are discussed. Each term (focal point) heading a group has its subdivisions listed both in the key and in the glossary. Likewise, cross references to the focal points are also contained in the definitions of the final subdivisions. For example, **Water Opening** lists **Crack, Lead, Polynya,** and Other as its subdivisions, while the definition for **Crack** refers to its relation to **Water Opening.**

Each term in the glossary is given a classification symbol. This symbol refers to the position of the term in the key. It indicates not only associated terms, but also the relative position of each term with respect to them. The classification symbol is formed by writing in succession the symbols of the applicable subdivisions in the key. For example, **Lead** is associated with: I. **Sea Ice,** C. Related Features, 1. **Water Opening,** and b. **Lead.** Its symbol, therefore, is (I.C.1.b.). Conversely, the symbol (I.C.1.b.) indicates **Sea Ice,** Related Features, **Water Opening, Lead.** Thus, a **lead** is a **water opening,** a related feature of **sea ice.**

The illustrations are assembled into groups to conform with the divisions of the key so that comparative studies of similar, yet different, ice terms can be made easily. The key lists the figure numbers so that the illustrations corresponding to a particular term may be found readily. If a term defined in the glossary is illustrated, the figure numbers are listed following the definition.

If the glossary is searched for a term made up of two words and the

term is not found under the first word, the order of the words should be reversed. For example, *ice shelf* is defined under **shelf ice.** If the meaning is changed by this procedure, both definitions will be given, each in its proper place, as for example, **ice river** and **river ice.** Many terms begin with the word "ice" so that this series of terms should be investigated for terms not otherwise easily found.

When several ice terms have the same meaning, all are listed in the glossary. However, one of these terms has been selected as the preferred term and the definition given under that term. The terms in bold face type in the text, captions, and key are defined in the glossary. In cases of ice terms having more than one meaning, all definitions have been given together with their key classifications.

In definitions, the abbreviation "cf." has been used to indicate parallel terms, while the word "see" indicates references to a larger division. For example, under **crack** will be found: Cf. **lead.** See **water opening.**

The following key is an integrated collection of observable ice features, arranged into logical groups for specific purposes. Although the newer knowledge of tomorrow may dictate other arrangements of ice terms, a beginning—good or bad—is needed today.

KEY TO THE ICE GLOSSARY

ICE GLOSSARY

ABLATION: (V.C.)—The disappearance of an ice or snow surface by melting and/or evaporation. Some writers limit the meaning to include all changes leading to the formation of vapor directly from ice, i. e., **sublimation;** other writers apply the term in a wider sense to the combined processes by which the surface wastes.

ABRASION:

(1) (II.B.)—The act or process of rubbing or wearing away, as the abrasion of rock or earth by glaciers.

(2) (II.B.)—The resulting injury or other effects of abrading; an abraded place, as the abrasion left by glacial action.

ACTIVE GLACIER: (II.A.2.)—A **glacier** in motion.

ACTIVE LAYER: (II.B.)—The zone, subject to annual freezing and thawing, between the surface of the ground and the **permafrost.** The depth of the **active layer** differs from one locality to another, ranging from a few inches to several feet.

AGE (of ice): (I.A.3.)—The stage in the ice cycle from inception to dissolution. Not to be confused with Ice Age, a subdivision of geologic time.

Under standard conditions fresh water freezes at 32°F., but sea water freezes at various lower temperatures depending on its salinity. The greater the salinity, the lower the freezing point. For sea water of average salinity (about 35 parts per thousand) the freezing point is 29°F. Ice forms first in shallow water near the coast or over shoals and banks, particularly in bays, inlets, and straits in which there is no current; also in regions with reduced salinity, such as those near the mouths of rivers. It spreads from these areas as centers. Such ice, broken up and carried seaward by winds or currents, facilitates ice formation in deeper water. Ice not melted during the previous season also acts in the same way. Wave action ordinarily hinders the formation of ice to some extent by mixing the waters of the upper layers. The presence of old ice damps out waves or swell and at the same time tends to assist the beginning of the freezing process by cooling the water.

The first sign of freezing is an oily or opaque appearance of the water caused by the formation of **ice spicules** and **ice crystals** in the form of thin plates about one-third of an inch across. These consist of fresh ice free from salt and increase in number until the sea is covered by **slush** of a thick, soupy consistency. **Slush** does not have any degree of hardness. It causes the sea surface to have a grayish or leaden color and causes the wind ripples to disappear. **Slush** generally does not exceed a thickness of 12 inches.

Ice crust is the next stage of development. It is generally transparent, has some degree of hardness, and is frequently rubbery. **Newly-formed ice**

955934O—52—3.

is weak and plastic in consistency, and does not acquire its strength and characteristic brittle nature until it has been cooled below 16°F.

Young ice is hard and brittle. It frequently has some slight degree of transparency and is generally 2 to 8 inches thick. **Young ice** has a sufficient degree of hardness to bear light and medium loads.

Winter ice is one season's growth.

Polar ice is the thickest and heaviest form of **sea ice** more than one year old. Undisturbed **polar ice** is about 12 feet thick on the average.

Rotten ice is ice that is disintegrating, regardless of its former condition. It is honeycombed and waterlogged and will not bear much weight.

The above is an outline of the complete **sea ice** cycle. The cycle may be interrupted at any stage and set back to a previous stage or forward to the final one. It is probable that only the ice formed well within the polar regions undergoes the entire cycle. The stages are gradational and difficulty will sometimes be encountered in making distinctions. It is quite usual to find adjacent ice in two or more stages of development, particularly at the higher latitudes. In the Weddell Sea on more than one occasion the formation of **pancake ice** was observed to take place during the melting and decay of **pack ice,** although the occurrences are rare.

ALIMENTATION (of glaciers): (V.C.)—A combination of processes contributing to the growth and maintenance of **glaciers;** sometimes termed the nourishing of glaciers. While accumulation of snowfall is usually the principal factor, condensation of water vapor into its various solid forms and snowslides are important agents. In parts of the Russian Arctic, e.g., Novaya Zemlya, condensation is the major factor.

ALPINE GLACIER: (II.A.2.b.)—**Valley glacier.**

ANCHOR ICE: (I.B.1.d.)—**Bottom ice.**

ANTARCTIC WHITEOUT: (V.B.)—Cf. **arctic whiteout.**

APRON:

(1) (I.C.2.)—**Ram.**

(2) (II.A.3.e.)—**Ice apron.**

(3) (II.A.1.a.)—An outspread alluvial deposit with generally outward slope, deposited by a stream or streams in front of a **glacier.**

ARCHED ICEBERG: (II.A.5.a.)—An **iceberg** eroded in such a manner that a large opening at the water line extends horizontally through the **iceberg** forming an arch. See **iceberg.** (Figs. 89, 94.)

ARCTIC PACK: (I.A.3.e.)—**Polar ice.**

ARCTIC SEA SMOKE: (V.B.)—**Frost smoke.**

ARCTIC WHITEOUT: (V.B.)—A peculiar condition affecting visibility caused by a snow cover obliterating all landmarks and accompanied by an overcast sky or cirrostratus and/or altostratus clouds. No shadows are cast and the picture is one of an unrelieved expanse of white. Earth and sky blend so that the horizon is not distinguishable. This condition

is extremely dangerous to low-flying aircraft, particularly those attempting to land. Pilots have well described the condition as "like flying in a bowl of milk." An analogous condition in the antarctic regions is called an **antarctic whiteout.**

AVALANCHE: (II.B.)—Masses of snow detached from great heights in the mountains and acquiring enormous bulk by fresh accumulations as they descend. When they fall into the valleys below, they often cause great destruction. Cf. **glacier.**

AVALANCHE ICE: (II.A.3.e.)—An ice mass fed entirely by **avalanches** from the edge of **continental ice, island ice, highland ice,** or **cirque ice;** or from the overhanging end of a **valley glacier** or **wall-sided glacier** cut off high on a mountain side. See **land ice.** Cf. **avalanche.**

BALL ICE: (I.A.1.f.)—Numerous floating spheres of **sea ice** having diameters of one to two inches. The balls are very soft and spongy; no internal structure can be distinguished clearly. The balls are generally in belts similar to **slush** which forms at the same time. **Ball ice** has very rarely been reported.

BARBER: (V.B.)—**Frost smoke.**

BARRANCA: (II.B.)—A rift in **piedmont ice, shelf ice,** or **ice tongue afloat.**

BARRIER:

(1) (II.A.4.a.)—**Shelf ice.**

(2) (II.A.4.a.)—**Shelf ice** in some particular geographic locality, e.g., Ross Barrier.

BARRIER ICEBERG: (II.A.5.a.)—**Tabular iceberg.** See **iceberg.**

BAY: (I.C.1.d.)—An inward bend of the **ice edge** or the **ice limit,** formed either by wind or current. See **water opening.**

BAY ICE: (I.A.3.c.)—Young, flat ice of sufficient thickness to impede navigation. In the antarctic this term also has been used at times for heavy **land floes.**

BELT: (I.A.1.f.)—A relatively narrow band of fragments of **floating** or **fast ice** of any concentration. Cf. **patch, tongue.** (Fig. 9.)

BENDING: (V.C.)—The first stage in the formation of **pressure ice** caused by the action of current, wind, tide, or air temperature changes. **Bending** is more characteristic of thin, plastic ice than heavier forms. (Fig. 79.)

BERG: (II.A.5.a.)—**Iceberg.**

BERGSCHRUND: (II.B.)—The **crevasse** or series of **crevasses,** deep and often broad, frequently occurring at the source of a **valley glacier** between the **glacier ice** and the mountain itself. The **bergschrund** becomes filled with snow and closes up during the winter, but reopens on the return of summer.

BERGY BIT: (II.A.5.b. or I.A.4.f.)—A medium-sized fragment of **glacier ice,** or **heavy floe,** or **hummocky pack ice,** washed clear of snow and floating in the sea or aground. A typical **bergy bit** is about the size of a small cottage. Cf. **iceberg, growler.** (Figs. 73, 99.)

BESET: (V.A.)—Hemmed in, surrounded by ice from all quarters so that control of the movements of a vessel is lost. **Beset** does not imply the presence of ice under pressure. Cf. **nipped, icebound.**

BIG CLEARING: (I.C.1.c.)—**Polynya.**

BIGHT: (I.C.1.d.)—An extensive inward bend of an **ice edge** or of an **ice limit.** Cf. **bay.**

BIT: (I.A.2.a.)—A single fragment of **brash,** not to be confused with **bergy bit.**

BLACK AND WHITE ICEBERG: (II.A.5.a.)—An **iceberg** having a dark, opaque portion containing sand and stones, and separated from the white portion by a definite line of demarcation. See **iceberg.**

BLACK ICE: (I.A.3.b.)—Transparent **ice crust** which reveals the color of sea water beneath. Cf. **ice crust, rotten ice, young ice.**

BLIND LEAD: (I.C.1.b.)—A **lead** with only one outlet, as a blind alley. See **water opening.** (Fig. 64.)

BLINK: (V.B.)—A glare on the underside of extensive cloud areas created by light reflected from snow or ice covered surfaces; also observable in a clear sky. **Blink** caused by ice surfaces is usually yellowish-white in contrast to the whitish, brighter glare caused by snow surfaces. This distinction is sometimes difficult to perceive. In contrast to **snowblink** and **iceblink,** the sky is dark above bare land or open water surfaces. See **sky map.**

BLOCK: (I.A.2.b.)—A fragment of **sea ice** ranging in size from 6 to 30 feet across. Cf. **floe.** (Figs. 11, 13, 15, 22, 29, 33, 78, 88.)

BLOCKY ICEBERG: (II.A.5.a.)—An **iceberg** with steep, precipitous sides, and with either a horizontal or nearly horizontal upper surface. Cf. **tabular iceberg** and **tilted iceberg.** See **iceberg.** (Fig. 91.)

BLUE ICE: (II.A.)—The oldest and hardest form of **glacier ice.** It is distinguished by a slightly bluish or greenish color.

BORING: (V.A.)—Forcing a vessel under power through ice by breaking a **lead** (Fig. 30).

BOTTOM ICE: (I.B.1.d.)—Ice formed on the bed of a river, lake, or very shallow sea irrespective of its nature of formation. Cf. **fast ice.**

BRASH: (I.A.2.a.)—Small fragments of **sea, lake,** or **river ice** less than 6 feet across; the wreckage of other forms of ice. Cf. **floe.** (Figs. 11, 12, 15, 22, 68, 78, 88.)

BRIDGE: (I.A.1.f.)—A light formation of snow or ice joining two heavier formations. Cf. **ramp, ice bridge.**

BROKEN BELT: (I.A.1.f.)—The transition zone between **open water** and **pack ice.**

BROKEN ICE: (I.A.1.c.)—Ice that covers from five- to eight-tenths of the sea surface. See **concentration** (of ice). (Figs. 5, 6.)

BUCKING: (V.A.)—Repeatedly charging the ice with a ship under full power in an attempt to break through the ice. Cf. **ramming.**

BULB GLACIER: (II.A.3.a.)—**Expanded foot ice.**

CAKE: (I.A.2.)—**Ice cake.**

CAKE ICE: (I.A.1.)—An area of **ice cakes.**

CALVED ICE: (II.A.5.)—A fragment of floating **glacier ice** ranging in size from an **iceberg** to a **growler.** See **iceberg.**

CALVING: (II.B.)—The breaking away of a mass of ice from its parent **iceberg, glacier,** or **shelf ice** formation.

Calving may take place above, at, or below the water line, relieving stresses set up by temperature changes and responding to vibrations from sound or wave action. **Icebergs** at any time may calve off large sections of ice which, after falling into the water, may bob up to the surface with great force, often at a considerable distance away. In the **calving** of the largest **valley glaciers** of Greenland, masses of ice of the order of 1/40 to 1/20 cubic mile are spalled off—one of the most gigantic natural spectacles on earth. The waves which are produced in the fiords rise several tens of yards along the banks and therefore compare favorably with the largest waves of the sea.

Icebergs are often so balanced that this **calving,** or merely melting of the under surface, will cause a shift in the center of gravity with consequent capsizing and readjustment of mass to a new state of equilibrium. Vessels and boats should therefore keep well clear of **icebergs** that give evidence of disintegrating or overturning. Cf. **capsize.** (Frontispiece, Figs. 73, 78, 86.)

CANDLE ICE: (I.A.3.f.)—Ice fingers normal to the original free surface in rotten or disintegrating **sea ice.** The fingers may be equal in length to the thickness of the **ice cake** prior to disintegration.

Candle ice is also a feature of disintegrating **lake** and **river ice.**

CAPSIZE: (II.B.)—To turn over. When the balance of an **iceberg** is changed sufficiently, it turns over or capsizes.

CHANNEL: (I.C.1.b.)—**Lead.**

CIRQUE: (II.B.)—A large, circular or nearly circular, steep-walled, rock recess or hollow in the side of a mountain or hill, generally ascribed to glacial erosion. In low and middle latitudes **cirques** are found in lofty highlands; in high latitudes they may occur within a few hundred feet of sea level. The French term, **cirque,** is widely used. In Wales, **cwm** (pronounced *koom*) is used; in Scotland, **corrie.** (Fig. 67.)

CIRQUE ICE: (II.A.1.d.)—Ice contained within a circular or nearly

circular hollow in the side of a hill or mountain. **Cirque ice** may be stagnant or it may overflow from its basin to produce a **glacier.** See **land ice.**

CLEARING: (I.C.1.c.)—**Polynya.**

CLOSE ICE: (I.A.1.d.)—Ice covering from eight- to ten-tenths of a sea water area. See **concentration** (of ice). (Fig. 7.)

CLOSE PACK: (I.A.1.d.)—**Close ice.**

COAST ICE: (I.B.1.b.)—**Fast ice.**

COASTAL ICE: (I.B.1.b.)—**Fast ice.**

COLLAR ICE: (I.B.1.a.)—**Ice foot.**

COMPACT ICE: (I.A.3.)—**Conglomerated ice.**

COMPOUND PANCAKE ICE: (I.A.3.)—**Pancakes** which have frozen together.

CONCENTRATION (of ice): (I.A.1.)—The ratio of the areal extent of ice present to the total areal extent of ice and water. **Concentration** is usually reported in tenths; for example, a water area may be five-tenths or six-tenths covered with ice. Descriptive terms most frequently used to describe the **concentration** are:

Open water—less than one-tenth ice cover,

Scattered ice—one- to five-tenths ice cover,

Broken ice—five- to eight-tenths ice cover,

Close ice—eight- to ten-tenths ice cover,

Consolidated ice—ten-tenths ice cover revealing no sea surface.

CONCRETE: (V.C.)—Snow compacted by heavy objects. **Concrete** becomes most evident when lighter snow has blown away, leaving compacted snow in low ridges. Footprints and tracks of vehicles are examples.

CONCUSSION CRACK: (I.C.1.a.)—A **crack** produced by the impact of one **ice cake** upon another.

CONFLUENT ICE: (II.A.3.d.)—An **ice sheet** formed by the coalescence of **ice tongues** from several glaciers, but given a definite form and trend by the presence of a land bar along its seaward edge. A coastal plain is not necessary for the existence of **confluent ice.** See **land ice.**

CONGLOMERATED ICE: (I.A.)—All types of **floating ice** compacted into one mass. **Conglomerated ice** refers to the contents of an ice mass, whereas **consolidated ice** refers to the degree of compaction or concentration of an ice mass. Cf. **consolidated ice.**

CONSOLIDATED ICE: (I.A.1.e.)—A **sea ice** area entirely devoid of sea water spaces usually containing the heavier forms of ice. **Consolidated ice** implies that there is a ten-tenths ice cover present. See **concentration** (of ice). (Fig. 8.)

CONTINENTAL GLACIER: (II.A.1.a.)—**Continental ice.**

CONTINENTAL ICE: (II.A.1.a.)—Ice which inundates a large land mass. The criteria for **continental ice** are: (1) The extent of the land

mass upon which the ice rests must be very great, and (2) the surface contours of the land must not be revealed on the upper surface of the ice. Cf. **highland ice.** See **land ice.** (Fig. 67.)

CORNICE: (II.B.)—Snow or ice overhanging an edge of a vertical cliff or a **crevasse** (Figs. 81, 82).

CORRASION: (V.C.)—The wearing away of the surface of ice or other material through the friction of solid material transported by water or air.

CORRIE: (II.B.)—**Cirque.**

CRACK: (I.C.1.a.)—A small, unnavigable, narrow break in **sea ice** that may reveal the sea water surface. **Cracks** are usually caused by tides, temperature change, current, and/or wind. See **water opening.** (Figs. 30, 36, 62, 63.)

CREAM ICE: (I.A.3.)—**Sludge.**

CREVASSE: (II.B.)—A fissure or rift in **glacier, shelf,** or other **land ice** formations, due to temperature changes or motion of the ice. **Crevasses** may attain depths of 200 to 300 feet, but are commonly less. (Figs. 71, 72, 76, 78, 97.)

CUL DE SAC: (I.C.1.b.)—**Blind lead.**

CWM (pronounced *koom*): (II.B.)—**Cirque.**

CWM ICE: (II.A.1.d.)—**Cirque ice.**

DEBACLE: (IV.)—The breakup of ice in a stream or the rush of water or ice that follows. Cf. **ice run.** (Fig. 103.)

DEBRIS ICE: (V.C.)—Ice which contains mud, stones, shells, etc.

DEGLACIATION: (II.B.)—The uncovering of any area as a result of **glacier** shrinkage.

DE-ICING: (V.A.)—The prevention or removal of ice accumulation on ships. A measure to facilitate the removal of ice by weakening its adhesion is the application of a **de-icing** dressing by brush or spray gun. Removal devices include: Ice spike or pick, shovels, ice axe or mattock, steam hose, and a cradle-mounted jet engine. Cf. **icing.**

DENDRITIC GLACIER: (II.A.2.b.)—A **mountain glacier** having lateral tributaries.

DEPTH ICE: (I.B.1.d.)—**Bottom ice.**

DISTURBED ICE: (II.B.)—Any **land ice** which is broken by pressure into a chaotic pattern of elevations and depressions. Cf. **pressure ice.**

DOME-SHAPED ICEBERG: (II.A.5.a.)—An **iceberg** eroded in such a manner that its upper surface is well-rounded and smoothly contoured. This type **iceberg** is more common in the antarctic than the arctic. See **iceberg.**

DONGA: (II.B.)—A small ravine, having steep sides, found in **piedmont ice** or **shelf ice.**

DRIFT:

(1) (V.B.)—Wind driven **snow.**

(2) (V.C.)—**Snow** lodged in the lee of surface irregularities.

(3) (V.A.)—The motion of **sea ice** or vessels resulting from current.

(4) (V.C.)—Any rock material, such as boulders, till, gravel, sand, or clay, transported by a **glacier** and deposited by or from the ice or by or in water derived from melting of the ice.

DRIFT ICE:

(1) (I.A.)—**Floating ice.**

(2) (V.C.)—Any ice that has drifted from its place of origin.

DRIFT ICE FOOT: (I.B.1.a.)—**Ramp.**

DRYDOCK ICEBERG: (II.A.5.a.)—**Valley iceberg.**

END MORAINE: (II.B.)—**Terminal moraine.**

EROSION: (V.B.)—The destruction of ice by weathering, solution, **corrasion,** transportation, and **ablation.** Cf. **weathered.**

ERRATIC: (V.C.)—A stone foreign to the local bedrock. The transporting agent may be **glacier ice.**

EXPANDED FOOT ICE: (II.A.3.a.)—The **lobe** or fan of ice formed beyond the mouth of a **valley glacier** from which the ice discharges into a broad valley or upon a plain. Other terms for the same feature are **bulb glacier** or **piedmont bulb. Expanded foot ice** occurs typically in Alaska. It is uncommon in the antarctic. See **glacier,** also **land ice.** (Fig. 75.)

FALSE ICE FOOT: (I.B.1.a.)—Ice formed along a beach terrace and attached thereto just above the high water mark. It is derived from water originating from melting snow above the beach terrace. This formation is termed a **false ice foot** because, unlike a true **ice foot,** it has its base above the low water mark. A **false ice foot** may be added to by accretions of **sea ice** resulting from waves, spray, and spring tides. Cf. **ice foot.**

FAST ICE: (I.B.)—All types of ice, either broken or unbroken, attached to the shore, beached, stranded in shoal water, or attached to the bottom of shoal areas. **Fast ice** may be classified as: (1) **Ice foot,** (2) **shore ice,** (3) **stamuhka,** or (4) **bottom ice.** (Fig. 61.)

FAST ICE BELT: (I.B.1.a.)—**Ice foot.**

FIELD: (I.A.2.f.)—**Ice field.**

FIORD, also **FJORD:** (II.B.)—A narrow, deep, steep-walled inlet of the sea formed by a **glacier.** (Frontispiece.)

FIORD ICE: (I.A.3.d.)—**Winter ice** formed in a **fiord.**

FIRN: (II.B.)—**Névé.**

FIRNIFICATION: (II.B.)—The process of conversion of snow into **glacier ice.**

FLAT ICE: (I.A.4.a.)—Ice having a flat or level surface. Cf. **pressure ice.** (Figs. 30, 36, 37, 62.)

FLAW:

(1) (I.B.4.)—The seaward edge of **landfast ice.** (Fig. 61.)

(2) (I.C.1.b.)—The **shore lead** just outside the **landfast ice.**

FLOATING ICE: (I.A.)—A general term applied to all types of ice (other than **icebergs** and other **land ice**) floating in the water. Floating ice may be classified by: (1) **Concentration,** (2) **size,** (3) **age,** and (4) **topography.**

FLOE: (I.A.2.)—The term **floe** is used for referring to fragments of ice (other than **icebergs** and other **land ice**) with no specific size intended. However, unlike the term **cake,** when **floe** is used with such qualifying terms as small, medium, or giant, a rather definite size is implied. Terms for describing **floes** of specific size are: **Brash, block, small floe, medium floe, giant floe,** and **ice field.** Another distinction is that a **floe** may consist of a single unbroken fragment of ice or many consolidated fragments, whereas **cake** implies a single unbroken fragment of ice. **Floe** is also used with such qualifying terms as heavy and light, but these terms imply thickness rather than areal limit.

FLOE BELT: (I.A.1.f.)—A **belt** consisting of **floes.**

FLOEBERG: (I.A.4.f.)—A mass of thick, heavily-hummocked **sea ice** resembling an **iceberg** in appearance. **Floebergs** may be from several feet to more than fifty feet in height. An **iceberg** in its last stages of disintegration may be mistaken for a floeberg. Cf. **iceberg, floe.** (Fig. 52.)

FOSSIL ICE: (II.B.)—Underground seams or lenses of ice formed only in regions of **permafrost.**

FRAZIL CRYSTALS: (I.A.3.a. or IV.)—**Ice crystals** in the form of spicules or thin plates formed in swiftly flowing streams or in turbulent sea water in which **sheet ice** formation is prevented. (Figs. 24, 25.)

FRAZIL ICE: (I.A.3.a. or IV.)—Cinder-like masses of ice resulting from accumulations of **frazil crystals** (Fig. 25).

FRESH ICE:

(1) (II., III., or IV.)—**Ice** formed from fresh water.

(2) (I.A.3.c.)—**Young ice.**

(3) (I.A.3.)—**Ice** that has been salty but now is fresh.

FROST: (V.B.)—Atmospheric moisture deposited through **sublimation** upon terrestrial objects in the form of **ice crystals** when the temperature is at or below freezing (Fig. 109).

FROST SMOKE: (V.B.)—A thick fog rising from the sea surface when relatively warm water is exposed to an air temperature much below freezing. **Frost smoke** frequently appears over newly-formed **cracks** and **leads.** If, however, the cold air moves across the sea surface with a

955934O—52—4.

rush—that is, as a strong wind—no fog is produced, as the vapor is distributed by the accompanying turbulence through too large a volume to produce saturation. (Fig. 106.)

GIANT FLOE: (I.A.2.e.)—A **floe** ranging in size from 3,000 feet to about 5 miles across. See **floe.** (Figs. 18, 19, 22, 35.)

GLACIAL: (II.B.)—Of or pertaining to a **glacier.**

GLACIATED: (II.B.)—Having been subjected to the action of **glaciers.** See **glacier.**

GLACIATION: (II.B.)—The alteration of any part of the earth's surface (usually by means of **erosion** or deposition) in consequence of **glacier ice** passing over it. See **glacier.**

GLACIER: (II.A.)—A flow of **land ice** from an area of ice accumulation. **Glaciers** originate in upland areas and usually terminate at sea level at high latitudes. A **glacier,** in contradistinction to an **avalanche,** moves slowly and is semi-permanent. Its extent is greater than that of an **avalanche** and it is composed of **ice** rather than **snow.** See **land ice.** (Figs. 69, 70, 86.)

GLACIER COVERED: (II.B.)—Describes areas now covered with **glacier ice.**

GLACIERET, GLACIERETTE:

(1) (II.A.1.e.)—**Snowdrift ice.**

(2) (II.A.1.d.)—A little **glacier.**

GLACIER ICE: (II.A.)—Ice which is formed in **glaciers.**

GLACIER ICEBERG: (II.A.5.a.)—An **iceberg** usually bluish or greenish in color, with little or no snow cover and often containing many **crevasses.** Such **icebergs** are smaller than **tabular icebergs. Glacier icebergs** are derived from **glaciers, piedmont ice, confluent ice,** or **ice tongues afloat.** See **iceberg.**

GLACIERIZED: (II.B.)—**Glacier covered.**

GLACIER TABLE: (II.B.)—**Ice pillar.**

GLAÇON: (I.A.2.)—A fragment of **sea ice** ranging in size from **brash** to a **medium floe.**

GLADE: (I.C.1.c.)—**Polynya.**

GLASS ICE: (I.A.3.b.)—**Ice crust.**

GLAZE: (V.B.)—A smooth, transparent or translucent coating of ice formed by the freezing of rain on terrestrial objects. See **ice storm.**

GLIMMER ICE: (I.A.3.)—**Newly-formed ice** within **cracks** or holes of older ice, or in the **puddles** upon older ice.

GRANULAR ICE:

(1) (V.B.)—**Rime.**

(2) (II.B.)—**Névé.**

GREASE ICE: (I.A.3.a.)—A kind of **slush** formed from the congelation

of **ice crystals** in the early stages of freezing. It gives the sea surface a greasy appearance.

GROUNDED ICE: (I.B.)—**Stranded ice.**

GROUND ICE:

(1) (I.B.1.d.)—**Bottom ice. Ice** formed on the bed of a river, lake, or shallow sea.

(2) (II.B.)—**Fossil ice. Ice** associated with **permafrost.**

GROWLER: (II.A.5.c. or I.A.4.f.)—A small fragment of ice awash, smaller than a **bergy bit,** usually of glacial origin, and generally greenish in color. See **iceberg.** (Figs. 72, 73.)

GROWLER ICE: (II.A.5.c. or I.A.4.f.)—An accumulation of **growlers.**

GULF ICE: (I.A.3.d.)—**Winter ice** formed in a gulf or bay.

HAYCOCK: (II.B.)—An isolated ice cone rising above the surface of **land ice** or **shelf ice** as a result of pressure or ice movement.

HEAVY FLOE: (I.A.2.)—A **floe** that is more than 10 feet thick. See **floe.**

HEAVY ICE: (I.A.)—Any **sea ice** more than 10 feet thick.

HEELING: (V.A.)—Causing a vessel to roll by mechanical means so as to enable it to gain headway when working in ice. Cf. **sallying.**

HIGHLAND ICE: (II.A.1.c.)—A comparatively thin, but continuous **ice sheet** overlying any flat or undulating land surface and conforming to a considerable extent to the irregularities of the land upon which it rests. Cf. **continental ice.** See **land ice.** (Fig. 68.)

HINGE CRACK: (I.C.1.a.)—A **crack** in **sea ice** running parallel and adjacent to a **pressure ridge.** The heavy weight of the **pressure ridge** is the primary cause of the **hinge crack.** See **water opening.**

HOARFROST: (V.B.)—**Frost.**

HOLE:

(1) (I.C.1.d.)—An opening through the **ice.**

(2) (I.C.1.d.)—An open space between **ice cakes.** Cf. **polynya.** See **puddle.**

HUMMOCK: (I.A.4.c.)—A mound or hillock in **pressure ice.** See **pressure ice.** (Figs. 40, 44.)

HUMMOCKED ICE: (I.A.4.c.)—Ice piled haphazardly into mounds or hillocks. At the time of formation **hummocked ice** is similar to **rafted ice** except that the former requires a greater degree of pressure and heaping than the latter. After **hummocked ice** and **rafted ice** have been repeatedly covered with snow and weathered, no distinction is then made between the two terms and **hummocked ice** is the term applied to both types. See **pressure ice.** (Figs. 40-44, 48, 52.)

HUMMOCKY FIELD: (I.A.4.c.)—A large area of **hummocked ice** (Figs. 42, 43).

HUMMOCKY FLOE: (I.A.4.c.)—A **floe** of **hummocked ice** (Fig. 41).

HUMMOCKY ICE: (I.A.4.c.)—**Hummocked ice.**

HUMMOCKY POLAR ICE: (I.A.4.c.)—**Polar ice** that has been hummocked.

HUMMOCKY WINTER ICE: (I.A.4.c.)—Ice one year old or less that has been hummocked.

ICE: (I., II., or V.B.)—The solid state of water formed either by freezing or **sublimation.**

Ice encountered at sea consists for the most part either of **icebergs** or other **land ice** originating from **continental ice** sheets and **glaciers,** or of **sea ice** formed by the freezing of the top layers of the sea itself. **Sea ice** proper accounts for probably 95 percent of the area of ice encountered at sea, but **icebergs** are important because of the manner in which they drift far from their place of origin, constituting grave menaces to navigation. A certain amount of **ice** also may originate in rivers or estuaries as fresh-water ice, but it is in a state of decay by the time it reaches the open sea and is of local importance only. See **land ice, river ice.**

ICE APRON:

(1) (II.A.1.a.)—Ice which is in part an accumulation of drift snow and in part the refreezing of thaw water from an **ice sheet** or **glacier** above, connecting with **avalanche ice** below (Fig. 70).

(2) (II.A.1.d.)—Area of snow and ice on **cirque** walls. Cf. **ice tongue.**

ICE ATLAS: (V.A.)—A series of charts showing geographic distribution of ice, usually by seasons or months.

The "Ice Atlas of the Northern Hemisphere," H.O. Pub. No. 550, 1946, is a good example. Cf. **ice chart.**

ICE BARRIER: (II.A.4.a.)—**Ice cliff.**

ICEBERG: (II.A.5.a.)—A mass of **land ice** that has broken away from its parent formation on the coast and either floats in the sea or is stranded on a shoal. The many different types of **icebergs** may be classed either as (1) **tabular,** generally derived from **shelf ice,** or (2) **irregular,** generally derived from **glacier** ice.

Names assigned to **iceberg** types depend upon either the content of the **iceberg** or its form. The names most frequently used are: **Pinnacled, arched, valley, drydock, blocky, tilted, weathered, glacier, black and white, sugar, tabular, barrier, névé, unconformity, ice island,** and **dome-shaped.**

In general, **tabular icebergs** having flat tops and angular contours are found in the antarctic, whereas the **irregular, pinnacled icebergs** are products of the arctic. **Weathering,** however, can alter the size and shape of an **iceberg** to such an extent that it can no longer be identified by form alone.

Icebergs do not frequently turn completely over. They will tip 90 degrees one day, then perhaps swing 80 degrees in another direction the next, but will seldom turn turtle. Irregular **icebergs** (**valley icebergs** excepted) in general are the least stable. Occasionally an **iceberg** will be observed with a regular oscillating movement, having a period measured in minutes.

Bergy bits, growlers, and **floebergs** are fragments of massive ice afloat as contrasted with the more laminar form of undisturbed **sea ice. Bergy bits** and **growlers** are more frequently the remnants or fragments of **icebergs.** They also may be products of well-hummocked **sea ice,** as are **floebergs** which are **floes** in origin but resemble small **icebergs** in appearance. (Frontispiece, Figs. 86-98.)

ICEBLINK: (V.B.)—A yellowish-white glare on the underside of extensive cloud areas created by light reflected from ice-covered surfaces. See **blink** and **sky map.** (Fig. 15.)

ICE BOULDERS, ICE BOWLDERS:

(1) (I.B.1.b.)—Large fragments of **sea ice** that have been shaped by **erosion** into the form of boulders or nearly spherical ice pieces and then forced ashore. See **shore ice.** (Fig. 56.)

(2) (V.C.)—Boulders (rock) transported and deposited through glacial action. Cf. **erratic.**

ICEBOUND: (V.A.)—Surrounded by ice so as to be incapable of advancing, as an **icebound** vessel. Cf. **beset, nipped.**

ICE BRIDGE: (IV.)—The freezing over of a river which impedes or prevents navigation by ordinary ships.

ICE CAKE: (I.A.2.)—A general term, like **floe,** used in reference to flat fragments of ice. The dimensions of a **cake** are not fixed and the term is used when no specific size is intended. Cf. **floe.**

ICE CAP: (II.A.1.a.)—**Continental ice.**

ICE CASCADE: (II.B.)—**Ice fall.**

ICE CAST: (I.B.1.a.)—Ice formed as a shell around pebbles on a beach as a result of wetting by spray, tide, and waves. Sometimes **ice casts** become detached from the parent pebbles and coalesce to serve as a nucleus for a **wash and strain ice foot.**

ICE CHART: (V.A.)—A chart showing the prevalence of ice, usually with reference to navigable waterways. Cf. **ice atlas.**

ICE CLIFF: (II.A.)—The cliff-like front of a **glacier,** or of **shelf ice** where it meets the sea (Figs. 78, 80-84).

ICE CRUST: (I.A.3.b.)—Thin, hard **sea ice. Ice crust** has varying degrees of whiteness depending upon age, thickness, and/or the rapidity of formation. Cf. **winter ice.**

ICE CRYSTAL: (I., II., III., IV., and V.B.)—The form in which ice

always occurs in nature. The shape of **ice crystals** depends on the conditions under which freezing takes place. (Fig. 28.)

ICE EDGE: (I.A.1.f.)—The boundary at any given time between **pack ice** and the open sea. It may be a regular line with considerable tightening of the floes along the edge, or may consist of a succession of **belts** or **patches,** or may be frayed out into a number of points and **bights,** with perhaps off-lying isolated fragments. The position of the **ice edge** depends on wind and tide and varies considerably from month to month and from year to year. The average position for any given month, based on observations over a number of years, is described as the monthly **ice limit.**

ICEFALL: (II.B.)—An interruption in the surface of a **glacier** caused by an abrupt change in the slope of its bed, resulting in **disturbed ice** usually in the form of steep or precipitous ice cascades. **Icefalls** interpose serious obstacles to travel over a **glacier** surface.

ICE FAT: (I.A.3.a.)—**Grease ice.**

ICE FIELD: (I.A.2.f.)—The largest of **sea ice** areas. An **ice field** is so called because of its size only (more than 5 miles across). The effects of pressure, **erosion,** or **age** have no part in the definition. See **floe.** (Figs. 20, 42, 43, 65.)

ICE FLOWERS: (V.B.)—Delicate tufts of **frost** or **rime** resembling flowers that occasionally form in great abundance on surface ice around salt crystals as nuclei (Fig. 26).

ICE FOG: (V.B.)—Fog formed of small, elongated **ice crystals,** usually under conditions of clear, cold, windless weather.

ICE FOOT:

(1) (I.B.1.a.)—A class of **fast ice** consisting of ice formed along and attached to the shore. The base of the ice is at or below low water mark. The action of tide, waves, and sea spray causes the development of the **ice foot** during the freezing season. Differences in the causative factors are reflected in the differences in the **ice foot.** Types of **ice foot** formations are: **Tidal platform ice foot, storm ice foot, drift ice foot, stranded ice foot, false ice foot,** and **wash and strain ice foot.** See **fast ice.** (Figs. 53, 54.)

(2) (II.A.)—The ice at the front of a **glacier.**

ICE FRINGE: (I.A.1.f.)—A **belt** of **sea ice** extending a short distance offshore.

ICE GANG: (IV.)—**Debacle.**

ICE GORGE: (IV.)—The damming of a river by ice fragments. The ponded river water above the dam may cause serious floods. Cf. **ice jam, debacle.**

ICE GRUEL: (I.A.3.a.)—A type of **slush** formed by the irregular freezing together of **ice crystals.**

ICE ISLAND:

(1) (II.A.1.b.)—**Island ice.**

(2) (II.A.5.a.)—**Ice island iceberg.**

(3) (II.A.5.a.)—A **tabular iceberg** whose extent is measured in miles.

(4) (V.C.)—A huge mass of floating ice in the Arctic Ocean. **Ice islands** have been estimated up to a few hundred feet thick and from 20 to 40 miles across. Their shape is similar to that of **tabular icebergs.** Their upper surfaces are covered with broad, shallow undulations and have individual drainage systems. The place and manner of origin of **ice islands** have not been determined.

ICE ISLAND ICEBERG: (II.A.5.a.)—A conical or dome-shaped **iceberg.** Under various lighting conditions an **ice island iceberg** will resemble an island in color and shape. (Fig. 98.)

ICE JAM:

(1) (IV.)—An accumulation of broken **river ice** caught in a narrow channel. Cf. **ice gorge, debacle.**

(2) (III.)—Fields of **lake ice** thawed loose from the shores in early spring may be blown against the shore exerting great pressures. Also, masses of broken-up ice may drift with the wind and produce jams on and against the shore.

ICE LEDGE: (I.B.1.a.)—**Ice foot.**

ICE LENS: (II.B.)—**Fossil ice.**

ICE LIMIT: (I.A.1.f.)—The greatest extent of ice at any given time. Cf. **Ice edge.**

ICE NEEDLE: (V.B.)—An **ice crystal** in the shape of a tiny, slender shaft.

ICE PACK:

(1) (I.A.1.)—Any large area of **floating ice** driven closely together. See **consolidated ice.**

(2) (I.A.1.)—The entire area of ice in the polar seas and the seas surrounding Antarctica (Figs. 23, 49, 50, 61).

ICE PILLAR: (II.B.)—A pedestal of ice on a **glacier** supporting a broader block of stone that has protected the ice beneath it from solar heating (Fig. 100).

ICE POLE: (V.C.)—The center around which is located the more consolidated portion of the arctic **ice pack.** The **Ice Pole,** or Pole of Inaccessibility as it is sometimes called, lies in the vicinity of latitude 83° to 84° N. and longitude 160° W.

ICE-PUSH TERRACE: (III.)—The comparatively permanent materials along a lake shore shoved up by successive **ice ramparts.**

ICE PYRAMID: (II.B.)—A mound of ice on a **glacier,** having stone or earthy debris lying against its foot.

ICEQUAKE: (V.C.)—The crash or concussion attending the breaking up of masses of ice, often due to contraction from extreme cold.

ICE RAMPART: (III.)—An irregular ridge on a sloping shore formed by **lake ice** pushing a portion of the marginal material to a higher level. See **lake ice.**

ICE RIND: (I.A.3.b.)—**Ice crust.**

ICE RIVER: (II.A.)—**Glacier.**

ICE RUN: (IV.)—The initial stage in the breakup of **river ice.** A weak section of ice floats free of its anchorage and releases the water stored above it. This extra water floats the next section free, releasing more stored water. All at once the whole river begins to move, the apparently solid cakes crumbling into **brash** as they strike the bank and against each other. A few **ice cakes** from shaded locations are still hard and strong. Armed with gravel and boulders frozen into their bottoms, they crash on bridge piers and grind wooden structures to matchsticks. However, the greater part of the ice disintegrates into **rotten ice** that melts while one watches it. The next day the river is running clear from bank to bank, with only a solitary **ice cake** lodged here and there on a sand bar. Breakup on rivers usually occurs 3 or 4 weeks after the mean air temperature has risen above 32°F. Cf. **debacle.**

ICE SHEET: (II.A.1.a.)—Any large area of continuous ice overlying a land surface. See **continental ice.**

ICE SPICULE: (I.A.3., II., III., IV., or V.B.)—A needle-like **ice crystal.**

ICE STORM: (V.B.)—A storm in which falling rain freezes as soon as it touches any object (Figure 108).

ICE STREAM:

(1) (II.A.)—**Glacier.**

(2) (I.A.1.f.)—**Belt.**

(3) (II.A.)—**Ice tongue.**

ICE TABLE: (V.C.)—A mass of level ice.

ICE TONGUE:

(1) (II.A.3.b.)—The extension of a **valley glacier** from the catchment basin to the terminus, i.e., the whole body of the **glacier** (Frontispiece).

(2) (II.A.1.d.)—A steep, narrow cliff of ice, rising high above glacial **névé** and extending upward toward the higher mountain peaks.

ICE TONGUE AFLOAT: (II.A.3.b.)—Extensions of the ice of **glaciers** that persist so far out to sea that their ends are afloat. An **ice tongue afloat** is perhaps the most striking of all the antarctic **land ice** forms. There is only one good example in the arctic.

The characteristics of the **ice tongue afloat** are, first and foremost, the long sub-triangular shape, and second, a contour very gently convex from side to side and shelving gradually from the shore towards the sea end until the free floating portion is reached, when the upper surface becomes a horizontal plane. **Crevasses** are usually few at the seaward

end and the **ice tongue** is bordered all around its seaward face by sharply defined perpendicular cliffs between 10 and 200 feet in height. The seaward end of a well-developed tongue rises and falls freely with the tide, and a **tide crack** between it and the **sea ice** is therefore usually ill-defined or absent altogether. (Fig. 76.)

ICE WORN: (V.C.)—Abraded by ice; specifically, rubbed, scratched, or channeled by glacial action.

ICICLE: (V.C.)—A pendent, usually conical, mass of ice formed by the freezing of dripping water (Figs. 109, 110).

ICING (of ships): (V.A.)—The formation and accumulation of ice on ships. **Icing** is caused principally by the freezing of spray on the superstructure when the sea water is about 30°F., the air temperature 20°F. or below, and the wind force 4 or greater. It will also form during occasional **ice storms.**

During **icing** in the arctic the wind, often rapidly veering, is usually northerly, stormy, squally, and sometimes described as piercing. The superstructure of the ship becomes very cold, so that any spray blown over it freezes immediately. The ice first envelops the lower weather decks and rails and with increasing wind climbs higher on the superstructure. Ice may build up at rates as high as 1½ inches per hour, particularly with a headwind. If the wind is on the beam, the ice will form on that side of the ship and thus cause a list which may become serious. Maximum **icing** takes place in bad weather, so that the difficulties for the crew engaged in **de-icing** are greatly increased by the ship's motion as well as the extreme cold. In general, smaller, well loaded vessels ice up more quickly than larger vessels of shallower draft. The ice is grayish white. Because of the salt content it is not as slippery or brittle as the ice formed in **ice storms.**

Icing resulting from **ice storms** at sea occurs when the raindrops are near freezing or supercooled and the ship's superstructure is below the freezing temperature of rain. The ice first forms on the masts, arms, lines, and antennas, and gradually overspreads the entire vessel. The ice thus formed is transparent, of uniform thickness, and very slippery. While it is probably more adhesive than frozen spray, it is more brittle. The total accumulation usually is not sufficient to endanger the stability of the ship, but because of the greater distance of the weight from the center of gravity the torque is greatly increased. Damage usually occurs to antennas, particularly the rigid type. A small, but very real danger to personnel exists when ice fragments from masts and lines fall to the decks.

Icing may also occur on lakes. Cf. **ice storms, de-icing.** (Figs. 104, 105.)

IRREGULAR ICEBERG: (II.A.5.a.)—**Pinnacled iceberg.**

955934O—52—5.

ISLAND ICE: (II.A.1.b.)—An island completely covered with **land ice. Island ice** is similar in all respects to **continental ice** except that the areal extent of the underlying land mass and the ice associated with **island ice** is decidedly smaller. The quantity of ice covering an island may be so great that the shape of the **island ice** approaches that of a dome, and a selvage of **land ice** floating in the water may circumscribe the island.

LAKE ICE: (III.)—Ice formed in lakes. **Lake ice** is usually, but not always, **fresh ice.**

Wind and wave action may prevent the complete freezing of large lakes when the air temperature falls below 32°F. On small lakes or in the sheltered portions of large lakes, ice forms when air temperatures fall below 32°F.

When ice has formed, a further decrease in temperature causes shrinkage cracks in the ice or breaks the shore contact, and additional water freezes in the cracks and around the shore. When the temperature rises expansion causes buckling of the ice or crowds the ice up the shore slopes. Such crowding exerts sufficient force to affect structures along the shore and to push lake bed materials shoreward above the water line, forming ridges or bars composed of materials from the shallower part of the lake bed. Such **ice ramparts** may be several feet in height and may contain large boulders. Where conditions favor permanency of ramparts once formed, successive shoves may build up a considerable accumulation of displaced materials, forming an **ice-push terrace.** Ice on lakes usually breaks up 5 or 6 weeks after the mean air temperature has risen above 32°F. (Fig. 101.)

LAND ICE: (II.)—Any ice formed on land masses, as an **ice cap** or **glacier.** The existence of **land ice** depends upon air temperatures below freezing and a supply of moisture for precipitation. Wright and Priestley divide **land ice** into five major types: (1) Ice in the area of supply or deposition, as **continental ice, island ice, highland ice, cirque ice,** and **snowdrift ice;** (2) ice in the area of movement or transmission, as **wall-sided glaciers** and **valley glaciers;** (3) ice in the area of wastage or dissipation, as **expanded ice foot, ice tongue afloat, piedmont ice, confluent ice,** and **avalanche ice;** (4) ice in the process of dissolution in the sea, as **icebergs, bergy bits,** and **growlers;** and (5) ice in the area of balanced forces, as **shelf ice.** See **ice.** (Frontispiece, Fig. 85.)

LANDFAST ICE: (I.B.)—**Fast ice.**

LAND FLOE: (I.A.2.)—An unusually thick fragment of **fast ice** which has become detached and is now afloat.

LAND SKY: (V.B.)—Dark streaks, patches, or a grayness on the underside of extensive cloud areas caused by the absence of reflected light

from the bare ground. **Land sky** is not as dark as **water sky.** See **sky map.** Cf. **blink.**

LANE: (I.C.1.b.)—**Lead.**

LARD ICE: (I.A.3.a.)—**Grease ice.**

LATERAL MORAINE: (II.B.)—Ridge of debris near the margin and parallel to the axis of a **glacier.** (Frontispiece, Figs. 71, 74.)

LEAD: (I.C.1.b.)—A long, narrow, but navigable water passage in **pack ice.** A **lead** may be covered by thin ice. See **water opening.** (Frontispiece, Figs. 28, 64, 65, 79.)

LEVEL ICE: (I.A.4.a.)—**Flat ice.**

LIGHT FLOE: (I.A.2.)—A **floe** that is less than two feet thick. See **floe.**

LIGHT ICE: (I.A.3.c.)—Ice less than two feet thick.

LILY PAD ICE: (I.A.2. or I.A.3.)—**Pancake ice.**

LOBATE: (II.A.3.c.)—Having lobes or rounded divisions, as the **lobate** terminus of a **glacier** (Fig. 69).

LOBE:

(1) (II.A.3.c.)—A rounded, marginal protuberance of **piedmont ice** (Fig. 77).

(2) (II.A.1.a.)—A great, rounded, marginal projection from a **continental ice** sheet.

LOLLY ICE: (I.A.3.a.)—**Frazil ice.**

LOOMING: (V.B.)—A common form of mirage. The appearance in the sky or on the horizon of objects that are normally hidden below the horizon is a common occurrence in the Far North. Images, sometimes upside down, may appear well up in the sky, resting on a pedestal or floating just above the horizon. The opposite, known as **sinking,** causes nearby objects which should be in clear view to disappear.

Looming may interfere with the identification of landmarks by distortion, may make estimation of vertical distances more difficult, may cause **icebergs** to resemble ships, and may suddenly reveal one's own craft to a distant observer.

LOOSE ICE: (I.A.1.c.)—**Broken ice.**

LOOSE PACK ICE: (I.A.1.c.)—**Broken ice.**

MARGINAL CRUSHING: (I.A.4.f.)—The destruction of the outer edges of **ice cakes** due to collision of the **cakes** (Fig. 23).

MEDIAL MORAINE: (II.B.)—A ridge of rock debris extending down the central part of a **valley glacier. Medial moraines** are the **lateral moraines** of tributary **glaciers** continuing down the main **glacier.** Their number depends on the number of tributaries of which the main **glacier** is built. (Frontispiece, Fig. 74.)

MEDIUM FLOE: (I.A.2.d.)—A **floe** ranging in size from 600 to 3,000 feet across. See **floe.** (Figs. 18, 96.)

MORAINE: (II.B.)—A ridge of rock debris deposited by a **glacier** (Frontispiece, Figs. 71, 74).

MOULIN: (II.A.2.)—A broad, circular depression on the ice surface of a **valley glacier** near its terminus. **Moulins** are caused by the entering of melt water into the crevasses of the **glacier.**

MOUNTAIN GLACIER: (II.A.2.)—**Valley glacier.**

MUDDY ICE: (V.C.)—**Debris ice.**

MUSH: (I.A.3.f.)—**Brash.**

NEEDLE ICE: (I.A.3.f.)—**Candle ice.**

NÉVÉ: (II.B.)—More or less loose, granular ice in transition from snow to **glacier ice. Névé,** in being buried about 100 feet, becomes compacted and gradually changes to **glacier ice.** The upper layers of **glaciers** and **shelf ice** are usually composed of **névé.**

NÉVÉ ICEBERG: (II.A.5.a.)—An **iceberg** similar in appearance and color to a **tabular iceberg** but composed of **névé** or compacted snow. See **iceberg.**

NEWLY-FORMED ICE: (I.A.3.)—A general classification for ice in the first stage of formation and development (Figs. 27, 28).

NEWLY-FROZEN ICE: (I.A.3.)—**Newly-formed ice.**

NIPPED: (V.A.)—Caught in the ice and subjected to pressure. Applied to ships caught fast in the ice. Cf. **beset, icebound.**

NIPPING: (V.A.)—The forcible closing of ice around a ship so that the ship is held fast by ice under pressure.

NIVATION: (II.B.)—The specific effects produced by **névé** in land sculpture as contrasted with those by **glacier ice,** called **glaciation.**

NUNATAK: (II.B.)—An isolated hill or mountain of bare rock rising above the surrounding **ice sheet. Nunataks** have been described as rock islands formed in a sea of ice with bands of **moraine** extending seaward from them.

OLD ICE: (I.A.3.e.)—Any **sea ice** over one year old.

OPEN ICE: (I.A.1.c.)—**Broken ice.**

OPEN LEAD: (I.C.1.b.)—A **lead** that is not covered with **newly-formed ice.**

OPEN PACK ICE: (I.A.1.c.)—**Broken ice.**

OPEN WATER: (I.A.1.a.)—Water that is less than one-tenth covered with **floating ice.** See **concentration** (of ice). (Fig. 1.)

OUTLET GLACIER: (II.A.1.a.)—The route by which the ice of **continental glaciers** escapes to the sea (Fig. 73).

PACK: (I.A.1.)—**Ice pack, pack ice.**

PACK ICE: (I.A.1.)—Any large area of **floating ice** driven closely together. See **concentration** (of ice).

PACKED ICE: (I.A.1.d.)—**Close ice.**

PALEOCRYSTIC ICE: (I.A.3.e.)—**Pressure ice,** usually more than ten years old, well weathered, and irregularly heaped and tumbled. The type locality is the Lincoln Sea.

PAN: (I.A.2.)—An abbreviation for **pancake ice.**

PANCAKE ICE: (I.A.2. or I.A.3.)—Pieces of **newly-formed ice** usually between one and six feet in diameter. The raised rims and the circular appearance are a result of the almost constant rotation and collision of the **cakes** against one another. Small **cakes** up to about 18 inches in diameter are occasionally called **lily pad ice.** (Fig. 29.)

PATCH: (I.A.1.f.)—An irregular cluster of **floating ice** fragments of any **concentration.** Cf. **belt, tongue.** (Fig. 10.)

PERMAFROST: (II.B.)—Permanently frozen ground. Any soil or even bedrock, irrespective of its texture, degree of induration, water content, or geological character, in which the temperature has been continuously below freezing over a period of years (varying from several to perhaps tens of thousands) is considered as permanently frozen ground.

PERMANENT ICE FOOT: (I.B.1.a.)—An **ice foot** that does not melt completely during the summer months.

PIEDMONT BULB: (II.A.3.a.)—**Expanded foot ice.**

PIEDMONT ICE: (II.A.3.c.)—An **ice sheet** formed by the coalescence of ice spreading out from two or more **wall-sided** or **valley glaciers** over a comparatively level plain at the base of the mountain slopes down which the **glaciers** descended. **Piedmont ice** may be partially afloat. See **glacier, land ice.** (Fig. 77.)

PINNACLED ICEBERG: (II.A.5.a.)—An **iceberg** that has been **weathered** and eroded in such a manner that spires or pinnacles extend vertically upward from the main body. See **iceberg.** (Figs. 87, 88.)

PLATE ICE: (I.A.3.)—**Pancake ice.**

POCKET: (I.C.1.b.)—**Blind lead.**

POLAR CAP ICE: (I.A.3.e.)—**Polar ice.**

POLAR ICE: (I.A.3.e.)—The thickest and heaviest form of **sea ice** more than one year old. Cf. **winter ice.** (Figs. 30-32.)

POLYNYA (pl. **POLYNYI**): (I.C.1.c.)—Any sizable sea water area, other than a **lead,** encompassed by ice. See **water opening.** (Fig. 66.)

POOL:

(1) (I.C.1.c.)—**Polynya.**

(2) (1.A.4.g.)—A depression on **sea ice** filled with water. See **puddle.**

PRESSURE ICE: (I.A.4.)—Ice having any readily observed roughness of the surface. **Flat ice** is the result of undisturbed ice growth and development, whereas **pressure ice** refers to a disturbed growth and development. Such disturbed development is the result of wind, current, tide, and/or temperature change. Types of **pressure ice** are: **Rafted,**

ridged, hummocked, tented, ropak, and **weathered.** See **topography** (of ice). (Figs. 38-52.)

PRESSURE ICE FOOT: (I.B.1.a.)—An **ice foot** formed along a shore line by the freezing together of stranded **pressure ice.**

PRESSURE RIDGE: (I.A.4.f.)—**Pressure ice** in the form of a ridge. **Pressure ridges** may be several miles long and up to 100 feet high. (Figs. 22, 47, 49, 50, 79.)

PUDDLE: (I.A.4.g.)—A depression on **sea ice** filled with melt water. During the summer, ice may absorb more heat than it radiates with the result that the surface of the ice melts and forms small **puddles. Puddles** grow individually or by running together. Since the melt water absorbs solar energy, it will cause holes to be melted through the ice to the sea water eventually. The water in **puddles** is much lighter in color than sea water. The melt water is frequently fresh enough for cooking and drinking purposes. **Puddles** are a surface feature that may occur on any ice. (Frontispiece, Figs. 7, 8, 16-18, 20, 21, 30, 32, 35-37, 42, 62, 65.)

PYRAMIDAL ICEBERG: (II.A.5.a.)—**Pinnacled iceberg.**

RAFTED ICE: (I.A.4.b.)—A type of **pressure ice** formed by one **cake** overriding another, or **rafting. Rafted ice** has well defined contours and when observed may be regarded as a relatively recent occurrence. See **pressure ice.** (Figs. 38, 39, 48.)

RAFTING:

(1) (I.A.4.b.)—The process of creating **rafted ice.**

(2) (V.C.)—The transporting of sediments, rocks, silt, and other matter of land origin out to sea by ice.

RAM: (II.B.)—The sloping, underwater ledge of an **iceberg** or of a **glacier** terminus bathed in water. More rapid melting at the water line than above and below causes a notch to be formed at the water line below which is the **ram.** As a result of underwater **calving,** the **ram** may become detached and is then buoyed up to the surface. This process can be a serious hazard for boats, even of large size, in the immediate vicinity. (Figs. 16, 57, 96.)

RAMMING: (V.A.)—Charging ice with a ship under full power. Repeated **ramming** is called **bucking.**

RAMP: (II.A.4.)—An accumulation of snow that forms an inclined plane between land or **land ice** elements and **sea ice** or **shelf ice.** Cf. **bridge.** (Figs. 83-85.)

REGIONAL CLEARING: (I.C.1.c.)—**Polynya.**

RIDGED ICE: (I.A.4.d.)—**Pressure ice** in the form of a ridge or many ridges. See **pressure ice.** (Figs. 45-47, 49.)

RIME: (V.B.)—A white or milky, opaque, granular deposit of ice which forms on exposed objects at temperatures below the freezing point.

RIVER ICE: (IV.)—Any ice formed in or carried by rivers.

Shallows and shoals in rivers of fresh or only slightly saline water, swept over twice a day by very powerful tides, are the most favorable places for the rapid formation of ice. If it is assumed that each tide sweeps away any ice formed during the ebb of the preceding tide, formation of new ice at the rate of perhaps 6 inches per day is a possibility, as in the winter climate of southern Quebec.

Ice expands and contracts with temperature changes in the same way as rocks, although the presence of water in contact with the under side of **river ice** reduces its range of temperature. Rising temperatures cause expansion that exerts outward pressure toward the banks. Normally there are enough weak points in the ice cover to permit the release of this pressure by buckling of the cover or crumbling of its edges. Occasionally the temperature rise is so rapid that enormous expansive pressures are developed at the edges of the ice where exposed piers, bulkheads, or sea walls are overturned or shoved bodily. When the expansion is less rapid the ice has time to adjust itself at weak points by crumbling and internal shear, so that little damage is done. Sometimes the entire frozen surface of the river bank, including rocks, earth, and sand, is sheared free from the unfrozen subsoil and piled up in characteristic long ridges parallel to the stream channel. This action on mid-channel sand bars piles them up above water level.

Similarly, falling temperatures cause contractions of the ice cover. As ice is very weak in tension, the stress is easily released by numerous **strain cracks.** The ice already shoved up on the bank is not retracted but remains perched on the bank. Contraction of ice is usually harmless to engineering structures. However, the combination of alternate expansion and contraction causes a ratchet action that is more severe than either action separately. As contraction takes place at colder temperatures, the water that rises in the **strain cracks** freezes at once, filling and sealing the cracks. When temperatures rise again the filled cracks cannot close, so that the entire expansion must take place at the edges of the cover. Similarly, compression cracks formed by buckling freeze solid and are stronger than before. Each cycle of contraction and expansion shoves the edges of the sheet farther up the bank.

Piers or walls exposed to the full force of ice expansion are usually protected by maintaining a belt of open water in front of them. As new ice freezes in the open lane of water, or as ice expansion closes it, this protective belt must be reopened and the ice cakes removed. A clever use can be made of the residual heat of the water under the ice. A perforated air pipe is placed along the bottom of the river in front of the wall or gate. The rising air bubbles drag warm bottom water upward and cause active circulation that prevents surface freezing and

even melts heavy sheet ice that has been shoved into the protecting lane.

Changes in the direction of the wind are sufficient to cause **floating ice** to shift from one side of the river to the other, or from one side of a slip to the other. Cf. **debacle, ice jam, ice run.** (Figs. 102, 103.)

ROCHES MOUTONNÉES: (II.B.)—Rounded rock hummocks found in glaciated regions, varying somewhat in shape according to the nature of the rock, its stratification or cleavage planes, and the action of the ice. Usually they have a smooth, rounded back (stoss end) pointing uphill and a rough downhill face (lee end) which is often steep.

ROPAK (pl. **ROPAKI**): (I.A.4.f.)—A pinnacle or slab of heavy **sea ice** which has been forced to stand on edge and thus extend vertically upward. The crests may rise 25 feet above the surrounding ice. See **pressure ice.** (Fig. 51.)

ROTTEN ICE: (I.A.3.f.)—Old ice which has become honeycombed in the course of melting and which is in an advanced stage of disintegration. **Rotten ice** may appear black through saturation with sea water. (Thin sheets of newly-formed, very thin ice also appear black, and may easily be confused with **rotten ice** when met in the **ice pack.**) See **winter ice, candle ice.** (Figs. 33-35.)

ROUGH ICE: (I.A.4.f.)—**Pressure ice.**

RUBBER ICE: (I.A.3.b.)—A type of **sludge** with an elastic quality and not strong enough to bear the weight of a man. See **age** (of ice).

RUBBLE: (I.B.1.b.)—Hard, somewhat spherical fragments of ice up to five feet in diameter resulting from the disintegration of larger ice. It may be either afloat or stranded on a beach.

SAILING ICE: (I.A.1.b.)—**Scattered ice.**

SALLYING: (V.A.)—Rolling a vessel by means of the crew's running from side to side in unison in order to loosen ice adhering to the vessel and to enable her to gain headway. Cf. **heeling.**

SALT FLOWERS: (I.A.3.a.)—**Ice flowers.**

SASTRUGI: (V.B.)—Wavelike ridges of hard snow formed on a level surface by the action of the wind (Fig. 107).

SCATTERED ICE: (I.A.1.b.)—Ice that covers from one- to five-tenths of the sea surface. See **concentration** (of ice). (Figs. 2-4.)

SCREE: (II.B.)—**Talus.**

SCREW ICE: (I.A.4.f.)—Ice fragments in heaps or ridges produced by crushing together of **ice cakes.** This term may include **ridged ice, hummocked ice,** and **rafted ice.**

SCREWING PACK: (I.A.4.f.)—**Ice cakes** in rotary motion due to the influence of wind and current.

SEA BAR: (I.A.1.f.)—**Belt.**

SEA ICE: (I.)—Ice formed by the freezing of sea water. See **ice.** (Frontispiece. Figs. 83, 85.)

SEA ICE SHELF: (I.A.)—**Sea ice** floating in the area of its formation and separated from **fast ice,** of which it may have been a part, by a **tide crack** or a family of such **cracks.**

SEA SMOKE: (V.B.)—**Frost smoke.**

SERAC: (II.B.)—A sharp ridge or pinnacle of ice among the **crevasses** of a **glacier.**

SHEAR CRACK: (I.C.1.a. or II.B.)—A **crack** in **sea ice** or **glacier ice** caused by two different forces acting tangentially and simultaneously on adjacent areas. The sheared parts undergo a displacement parallel to the plane of the **crack.**

SHEET ICE: (I., III., or V.)—Ice formed in a relatively thin, smooth layer over a water surface. This term should not be confused with **ice sheet,** a continuous layer of ice covering a large land area.

SHELF ICE: (II.A.4.a.)—A thick ice formation with level surface extending seaward from the land but attached thereto. **Shelf ice** may be formed in three ways: (1) By an extension of **land ice** onto water, (2) by the accumulation of snow upon **sea ice** which has persisted for several seasons, and (3) by a combination of (1) and (2), resulting in areas of **land ice** extending onto the water interspersed with areas of persistent **sea ice** covered with accumulations of snow.

The chief characteristics of **shelf ice** are: (1) A shape conforming to the boundaries of the coast, (2) a seaward edge usually floating freely in deep water, (3) vertical cliffs up to 150 feet high on the seaward edge, and (4) prominent horizontal banding and clean-cut joint faces from which **tabular icebergs** are **calved** periodically. See **land ice.** (Figs. 78, 84.)

SHOCK CRACK: (I.C.1.a.)—**Concussion crack.**

SHORE CLEARING: (I.C.1.b.)—**Shore lead.**

SHORE ICE: (I.B.1.b.)—Ice that has been cast onto the shore or beached as a result of the action of wind, waves, current, tide, or the force of an adjacent ice area. Such action may cause the **shore ice** to be **rafted** or heaped or may form **ice boulders.** See **fast ice.** (Figs. 55, 56.)

SHORE ICE BELT: (I.B.1.a.)—**Ice foot.**

SHORE LEAD: (I.C.1.b.)—A **lead** between **floating ice** and the shore or between **floating ice** and **fast ice** (Frontispiece).

SIKUSSAK: (I.A.3.e.)—Very old **sea ice** trapped in **fiords. Sikussak** resembles **glacier ice** since snowfall and **snowdrifts** contribute to its formation.

SINKING: (V.B.)—An optical phenomenon, the opposite of **looming,** in which an object on or slightly above the geometrical horizon apparently sinks below it. Cf. **looming.**

SIZE (of floating ice): (I.A.2.)—The linear extent of individual fragments of ice. In general, ice fragments are angular or circular. The

955934O—52—6.

linear dimension used for describing the **size** of the individual ice fragment refers to an approximation of the diameter. **Size** is usually observed in feet or miles, whichever is more convenient or applicable. The terms most generally used to describe ice fragments according to increasing **size** are in order: **Brash, block, small floe, medium floe, giant floe,** and **ice field.**

SKIN: (I.A.3.b.)—The first film or crust of **newly-formed ice. Skin** has some degree of hardness.

SKY MAP: (V.B.)—A pattern on the underside of extensive cloud areas created by the varying amounts of light reflected from the earth's surface. Snow surfaces produce a white glare in the sky **(snowblink)** and ice surfaces a yellowish-white glare **(iceblink).** Bare land and open water reflect little or no light and for this reason the clouds above these surfaces are relatively dark **(land sky, water sky).**

SLACK ICE: (I.A.1.c.)—**Broken ice.**

SLEET:

(1) (V.B.)—Frozen or partly frozen rain in the form of particles of clear ice (U.S. Weather Bureau definition).

(2) (V.B.)—Snow and rain falling together (World Meteorological Organization definition).

SLEWING: (V.A.)—Forcing a ship through the ice by separating adjacent **floes.**

SLOB: (I.A.3.b.)—A dense form of **sludge.** Originally defined as being so dense as to impede the progress of sealing vessels.

SLUDGE: (I.A.3.b.)—An accumulation of small pieces of soft ice mixed with **slush. Sludge** has a slight degree of hardness and is, therefore, a type of **ice crust.**

SLUDGE CAKE: (I.A.3.b.)—**Sludge** hardened into a **cake** strong enough to bear the weight of a man.

SLUDGE FLOE: (I.A.3.b.)—**Sludge cake.**

SLUDGE LUMP: (I.A.3.b.)—An irregular mass of **sludge** formed as a result of strong winds.

SLUSH: (I.A.3.a.)—An accumulation of **ice crystals** which may or may not be slightly frozen together. **Slush** has no degree of hardness. See **age** (of ice). (Fig. 10.)

SMALL FLOE: (I.A.2.c.)—A **floe** ranging in size from 30 to 600 feet in diameter. See **floe.** (Figs. 11, 16, 17, 22, 68, 78, 88.)

SNOUT: (II.A.2.b.)—The front or terminus of a **valley glacier.**

SNOW: (V.B.)—A form of precipitation composed of **ice crystals.** When atmospheric water vapor condenses at temperatures below 32°F. **ice crystals** form and may fall to the ground as individual crystals, although it is more usual for them to fall as snowflakes which are aggregations of

ice crystals. Counts of the number of crystals in a few snowflakes have shown that larger flakes may consist of as many as 100 crystals.

SNOWBLINK: (V.B.)—A white glare on the underside of extensive cloud areas created by light reflected from snow-covered surfaces. See **blink, sky map.** (Fig. 15.)

SNOW CRUST: (II.B.)—The frozen surface of a snow cover.

SNOWDRIFT: (V.B.)—Snow lodged in the lee of surface irregularities or heaped by the peculiarities of the wind itself.

SNOWDRIFT ICE: (II.A.1.e.)—Permanent and semi-permanent masses of ice or **névé** formed by the accumulation of drifted snow in the lee of projections or in depressions on the surface. **Snowdrift ice** is the initial ice formation from which **cirque ice** seems to originate. See **land ice.**

SNOW ICE: (I.A.3.b.)—**Ice crust** that has been formed in a considerable part from falling or drifting snow.

SNOW SLUDGE: (I.A.3.b.)—**Sludge** formed from **snow.**

SNOW SLUSH: (I.A.3.a.)—**Slush** formed from **snow** that has fallen into water at a temperature below that of the snow.

SPRING SLUDGE: (I.A.3.f.)—**Rotten ice.**

SPUR: (I.C.2.)—**Ram.**

STAGNANT GLACIER: (II.A.2.)—An inactive **glacier.**

STAMUKHA (pl. **STAMUKHI**): (I.B.1.c.)—A single fragment of **ice** stranded on a shoal. See **fast ice.** (Figs. 57-60.)

STEAM FOG: (V.B.)—**Frost smoke.**

STORIS: (I.A.4.f.)—A regional term applied to the remnants of the thickest, fused pressure ridges of **polar ice** drifting along the coast of Greenland from the Arctic Ocean. See **floeberg.**

STORM ICE FOOT: (I.B.1.a.)—An **ice foot** created by freezing spray (Fig. 54).

STRAIN CRACK: (I.C.1.a.)—A crack in **sea ice** caused by stresses deforming the ice beyond its elastic limit. See **torsion crack.**

STRANDED FLOE ICE FOOT: (I.B.1.a.)—**Stranded ice foot.**

STRANDED ICE: (I.B.)—Ice left or forced aground. Cf. **shore ice.**

STRANDED ICE FOOT: (I.B.1.a.)—An **ice foot** formed from **floes** and/or small **icebergs** stranded along a shore line. It may be built upward by breakers and wind driven spray.

SUBLIMATION: (V.B.)—The transition of the solid phase of certain substances into the gaseous and vice versa without passing through the usual liquid phase. Water possesses this property; thus, ice can change to water vapor or water vapor to ice. Strictly speaking, the word **sublimation** means the evaporation of ice and its immediate recondensation elsewhere, but it is also used to denote the single process of the condensation of water vapor into ice.

SUGAR ICEBERG: (II.A.5.a.)—An **iceberg** composed of the most porous type of **glacier ice.** Such ice is formed at very low temperatures, is loosely constructed, and falls apart easily. See **iceberg.**

TABULAR ICEBERG: (II.A.5.a.)—A mass of ice calved from **shelf ice,** with a flat upper surface and with at least the upper portion formed from a stratified snow or **névé.** A pronounced feature of the **weathering** of **tabular icebergs,** whether by atmospheric agents or by sea water, is the change in color from the original dazzling white to an equally beautiful blue. See **iceberg.** (Figs. 94-96.)

TALUS: (II.B.)—A heap of coarse rock waste at the foot of a cliff, or a sheet of waste covering a slope below a cliff. **Scree** is the term more commonly used in Great Britain, whereas **talus** is more commonly used in the United States. **Talus** slopes are very common in the more rugged parts of the arctic. (Frontispiece.)

TARN: (II.B.)—A small mountain lake or pool.

TELESCOPED ICE: (I.A.4.b.)—**Rafted ice.**

TENSION CRACK: (I.C.1.a.)—**Strain crack.**

TENTED ICE: (I.A.4.f.)—A type of **pressure ice** created in an area of **consolidated ice** when ice is displaced vertically upward forming a flat-sided arch and thus a cavity between the **tented ice** and the sea water surface. See **pressure ice.**

TERMINAL MORAINE: (II.B.)—Deposits of debris in front of or at the **snout** of a **glacier.**

THROUGH GLACIER: (II.A.2.)—A **glacier** heading on a low, flat divide from which ice streams flow in opposite directions. Such a **glacier** is said to be double-ended.

TIDAL PLATFORM ICE FOOT: (I.B.1.a.)—An **ice foot** produced between high and low water levels by the rise and fall of the tide.

TIDE CRACK: (I.C.1.a.)—A **crack** in **sea ice,** usually parallel to the shore, caused by the rising and falling tide. It thus separates the moving ice from the **ice foot.** Several such **cracks** frequently occur as a family.

TIDEWATER GLACIER: (II.A.2.b.)—A **glacier** that descends into the sea, where parts of it may break off to form **icebergs.**

TILTED ICEBERG: (II.A.5.a.)—A **tabular iceberg** that has become unbalanced, so that the flat, level top is inclined. See **iceberg.** (Fig. 91.)

TONGUE: (I.A.1.f.)—A projection of **floating ice** caused by wind and current. The extent of a tongue may be several miles. Cf. **belt, patch.**

TOPOGRAPHY (of ice): (I.A.4.)—The degree of surface roughness, from flat to extremely rough. The terms most frequently used (sometimes in combination) to describe the **topography** of ice are: **Flat, rafted, ridged, hummocked, weathered,** and **puddled.** See **pressure ice.**

TORSION CRACK: (I.C.1.a.)—A **crack** produced in **sea ice** by two

different but simultaneous forces twisting the ice beyond its elastic limit.

TRACKING: (V.A.)—Following the edge of an **ice pack.**

TRANSECTION GLACIER: (II.A.2.)—**Through glacier.**

TURRET ICE: (I.A.4.f.)—**Ropak.**

UNCONFORMITY ICEBERG: (II.A.5.a.)—An **iceberg** characterized by unconformities below which the ice is of different type from that above. The difference may be very marked, as between blue, water-formed ice and **névé,** or less marked so as not to be easily distinguishable unless separated by silt-bands. **Weathering** of this type of **iceberg** is accelerated by the presence of many **crevasses** and silt-bands. (Fig. 97.)

VALLEY GLACIER: (II.A.2.b.)—A stream of **land ice** that flows toward sea level through definite valleys. See **glacier, land ice.** (Frontispiece, Figs. 71-74.)

VALLEY ICEBERG: (II.A.5.a.)—An **iceberg** eroded in such a manner that a large U-shaped slot extends through the **iceberg** with large pinnacles or slabs on either side. Sometimes the slot is awash. These **icebergs** do not turn over, but sail on as majestically as a well-ballasted ship. **Valley icebergs** deteriorate chiefly by **calving** and melting at the water line. When the lightened **iceberg** rises a series of water lines circling the base is exposed. See **iceberg.** (Figs. 89, 90.)

WALL-SIDED GLACIER: (II.A.2.a.)—A stream of **land ice** that flows toward sea level unconfined by any marked valley wall. See **glacier, land ice.** (Fig. 69.)

WASH AND STRAIN ICE FOOT: (I.B.1.a.)—An **ice foot** formed from **ice casts** and **slush** and attached to a shelving beach between the high and low water marks. High waves cause the formation to build up above the high water mark later.

WASTAGE: (V.C.)—The direct or indirect conversion of ice into water or water vapor. It takes place by evaporation, melting, and **calving.**

WATER OPENING: (I.C.1.)—A break in **sea ice** that reveals the sea surface. Specific types of **water openings** are: **Crack, lead, polynya, bay,** and **bight.**

Frequently **water openings** exist in an ice area with the ice arranged either regularly or haphazardly. No specific term is applied to such **water openings.** In these cases the concentration of ice is described as **scattered, broken,** etc., depending upon the ratio of ice to sea surface.

WATER SKY: (V.B.)—Dark streaks, patches, or grayness on the underside of extensive cloud areas due to the absence of reflected light from **open water** areas. **Water sky** is darker than **land sky.** See **blink, sky map.** (Fig. 43.)

WATER SMOKE: (V.B.)—**Frost smoke.**

WEATHERED: (V.B.)—Descriptive of ice that has been destroyed **or**

955934O—52—7.

partially destroyed by thermal and mechanical processes (Figs. 41-44, 46, 93).

WEATHERED ICEBERG: (II.A.5.a.)—An **iceberg** whose irregularity is due to the advanced stage of its destruction, having been well **weathered** and/or overturned. The surface texture of a **weathered iceberg** resembles the **weathered** surface of polished white marble. Surfaces which have been under water have a honeycombed structure and a fused glass texture. (Fig. 93.)

WEIGHT CRACK: (I.C.1.a.)—**Hinge crack.**

WINTER ICE: (I.A.3.d.)—**Sea ice** more than 20 centimeters (8 inches) thick formed and developed in one winter. **Winter ice** is therefore one year old or less, and is usually less than 12 feet thick. However, if the ice is disturbed by external forces such as wind and current, the thickness of the ice cannot be used to infer its **age.** (Fig. 30.)

WORKING: (V.A.)—Negotiating ice by **boring** and **slewing.**

YOUNG ICE: (I.A.3.c.)—**Newly-formed ice** between 5 and 20 centimeters (2 to 8 inches) thick in the transitional stage of development from **ice crust** to **winter ice.** See **age** (of ice). (Figs. 28, 29.)

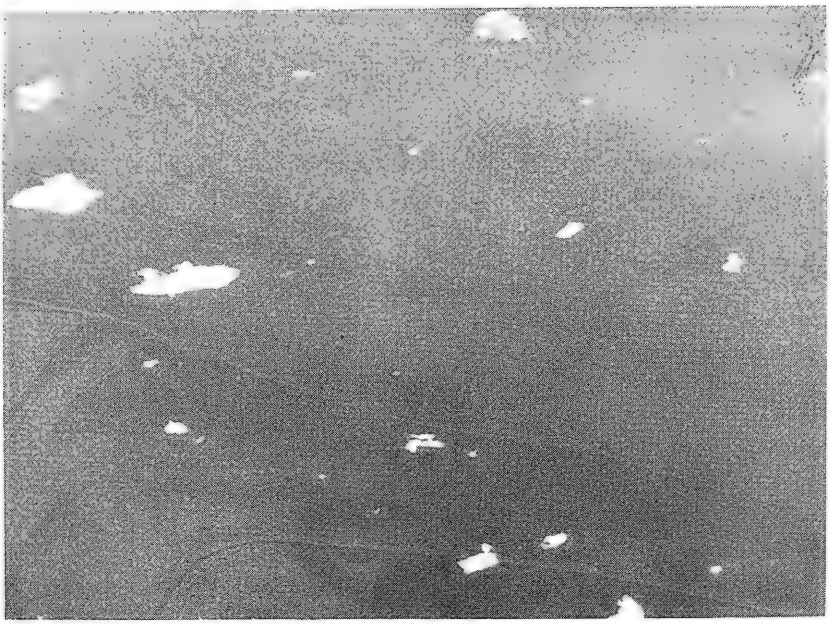


Figure 1—Masthead view of **open water** (less than one-tenth ice cover).

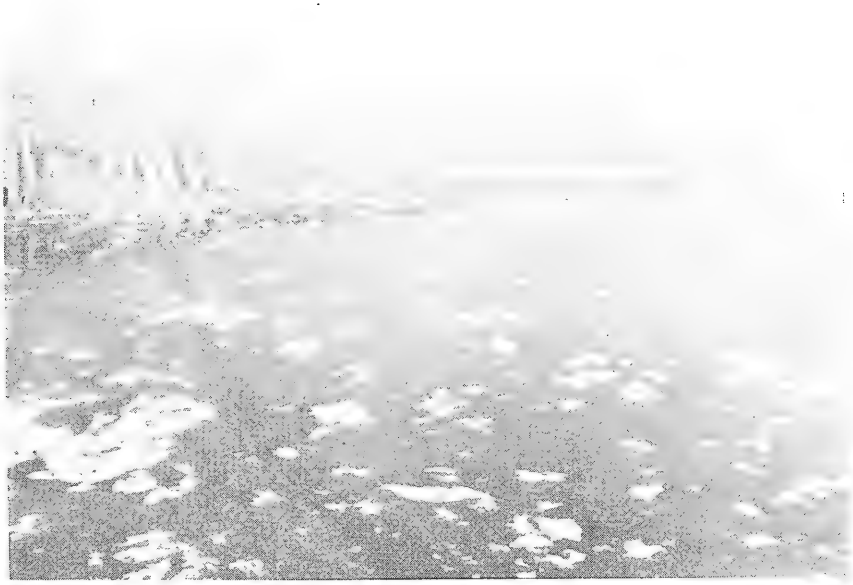


Figure 2—Aerial view of **scattered ice** (one- to five-tenths ice cover). The ice is regularly distributed over the water area.

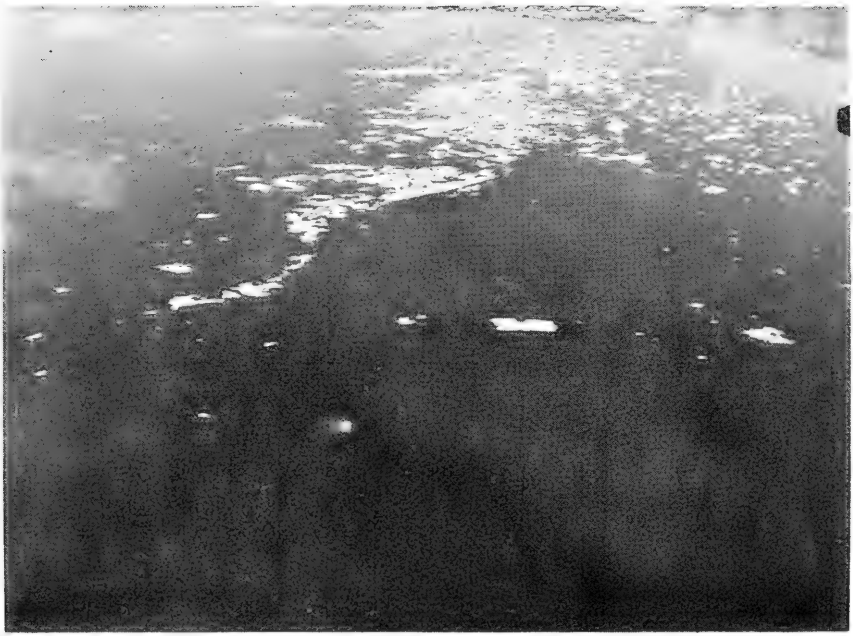


Figure 3—Aerial view of **scattered ice.** Here the ice is irregularly distributed over the water area.

Figure 4—Shipboard view of **scattered ice.**

Figure 5—Shipboard view of **broken ice** (five- to eight-tenths ice cover).

Figure 6—Aerial view of **broken ice** irregularly distributed over the water area.

Figure 7—**Close ice** (eight- to ten-tenths ice cover). **Puddles** of melt water are present on the ice surface.

Figure 8—Consolidated ice (ten-tenths ice cover revealing no sea surface). The ice surface is heavily puddled.

Figure 9—Aerial view of a **belt** of ice.

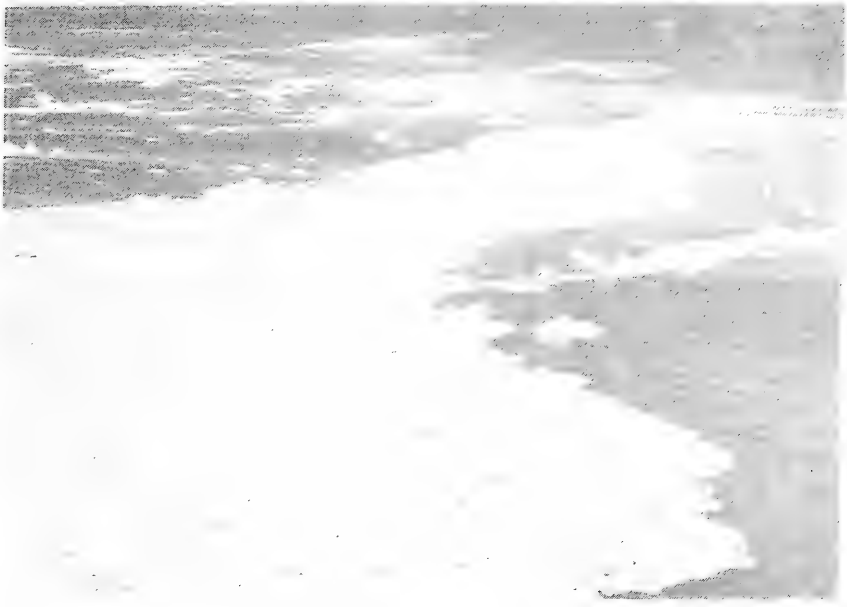


Figure 10—Shipboard view of a **patch** of ice. **Slush** is forming in the middle ground.

Figure 11—**Brash** between **blocks** and **small floes.** (Wright and Priestley.)

Figure 12—**Brash,** produced artificially by the passage of an icebreaker.

Figure 13—Block about 8 feet thick turned on edge revealing its laminar structure.

Figure 14—Blocks with a snow cover of about 4 inches. Laminar structure is shown by the foremost **block.**

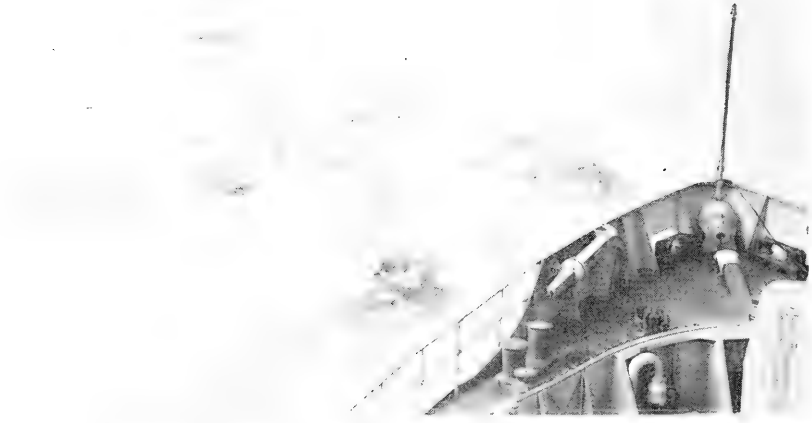


Figure 15—**Blocks** and **brash.** The dark streaks on the horizon are **water openings**—probably **leads.** Light on the clouds near the horizon may be **snowblink** or **iceblink.**

Figure 16—**Small floe** (30 to 600 feet across) with **ram.** A few **puddles** are on the surface of the **floe.**

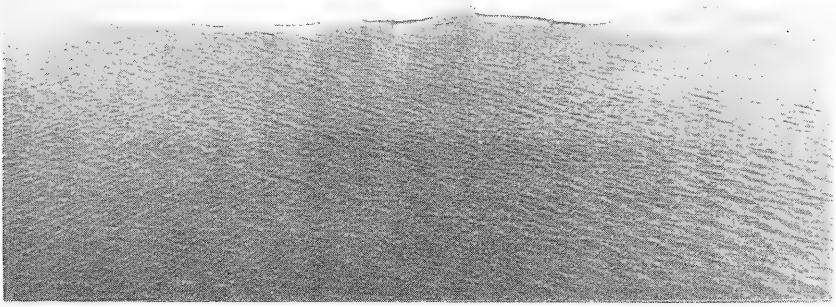


Figure 17—**Small floe** in foreground. The **puddles** on the **floe** have been formed from melting of the surface.

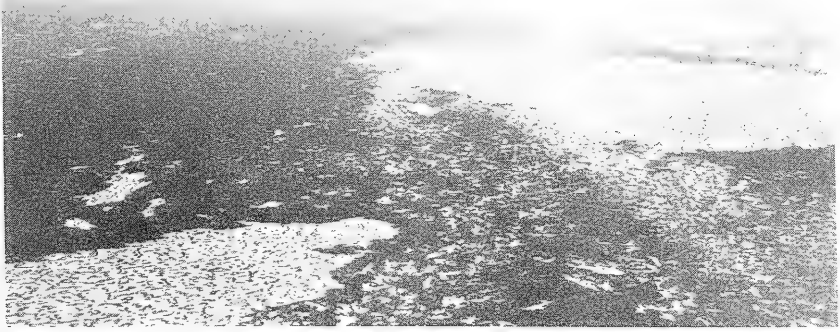


Figure 18—Aerial view of **medium** (600 to 3,000 feet across) and **giant floes** that have been well puddled.

Figure 19—Portion of **giant floe** (3,000 feet to 5 miles across).

Figure 20—**Ice field** (greater than 5 miles across) whose surface is well puddled.

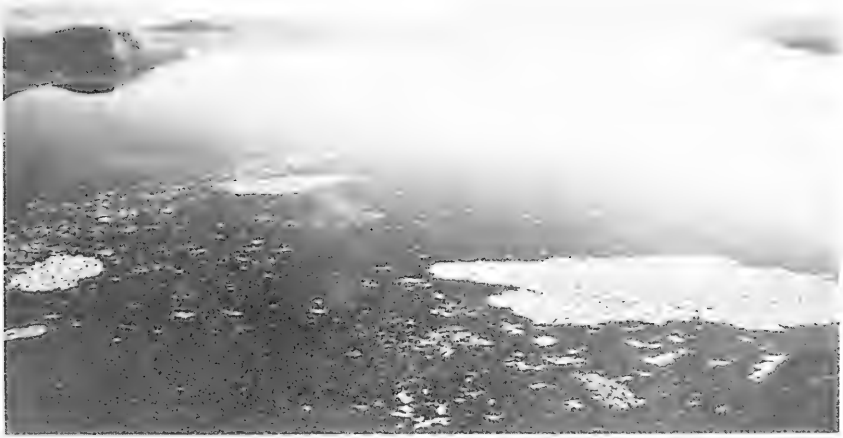


Figure 21—Aerial view of puddled **floes** of all sizes.

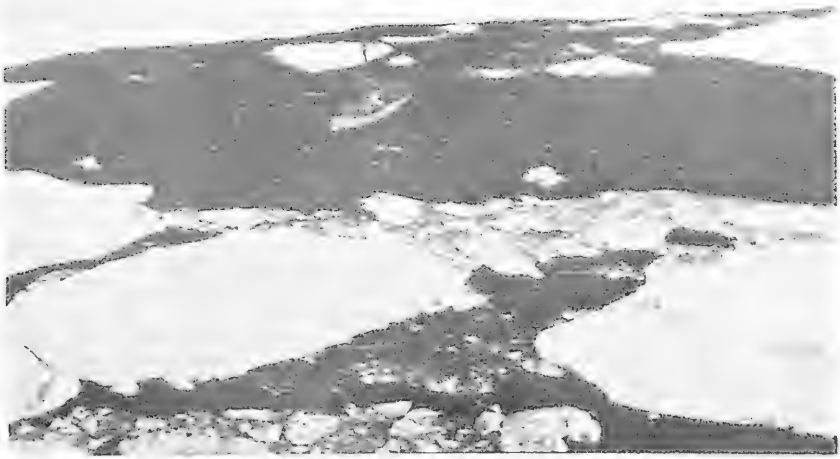


Figure 22—**Small floe** (in left foreground) accompanied by **blocks** and **brash.** The **floe** on the left has a flat surface; the **floe** on the right has a **pressure ridge.** A **giant floe** is in the background.

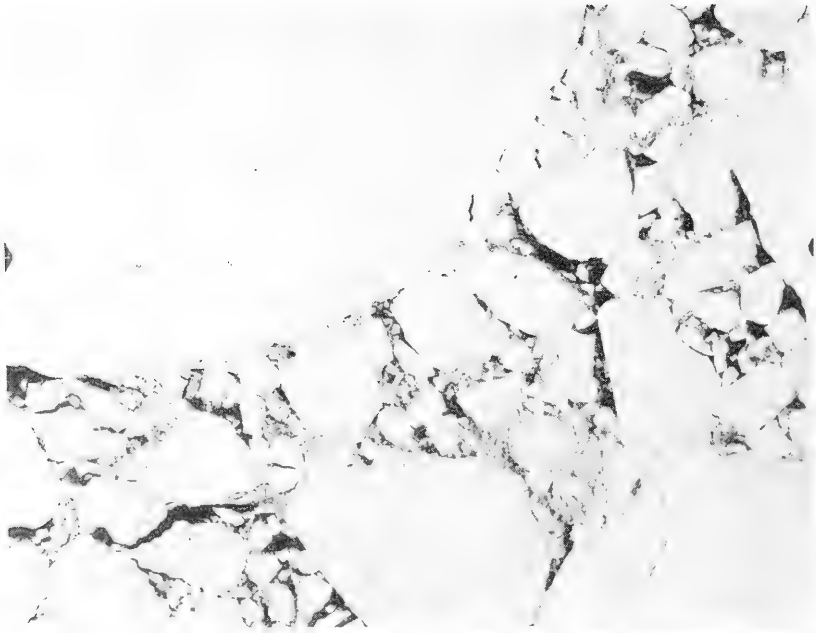


Figure 23—Aerial view of the **ice pack** showing **floes** of all sizes. **Marginal crushing** has destroyed the outer edges of the **floes.** (U.S. Air Force.)

Figure 24—**Frazil crystals** in the sea. **Ice foot** on the left. (Wright and Priestley.)

Figure 25—**Frazil ice** deposited on seaweed. (Wright and Priestley.)

Figure 26—**Ice flowers** on **newly-formed sea ice.** (Wright and Priestley.)

Figure 27—**Newly-formed ice** in the foreground with older ice in the background.

Figure 28—**Lead** in the process of freezing. The **newly-formed ice** is in a transitional stage of development from **ice crystals** to **young ice.**

Figure 29—**Pancakes** with **blocks** of **young ice.**

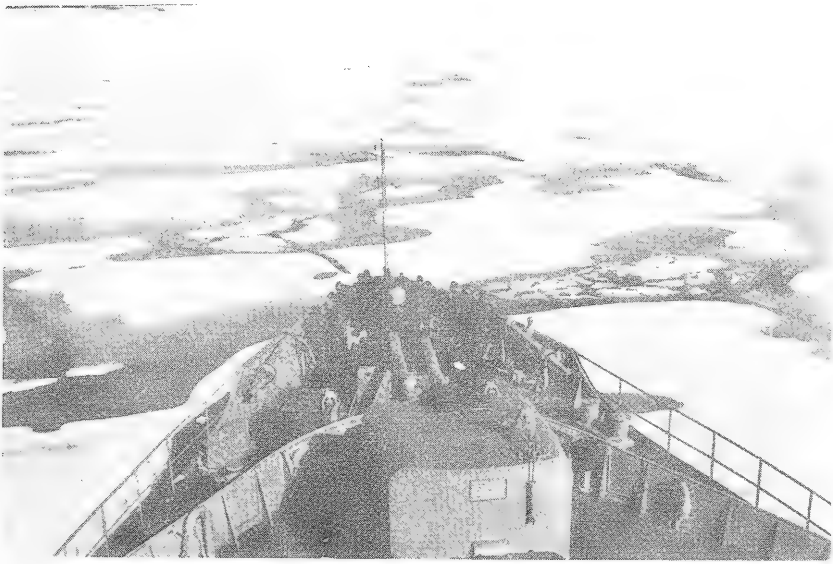


Figure 30—Flat, puddled **winter ice** in the foreground and **polar ice** in the background. The ship has just broken a zigzag **crack (boring).**

Figure 31—**Polar ice.**

Figure 32—**Polar ice** with **puddles.** The tone of the melt water in the **puddles** is much lighter than the sea water in the foreground.

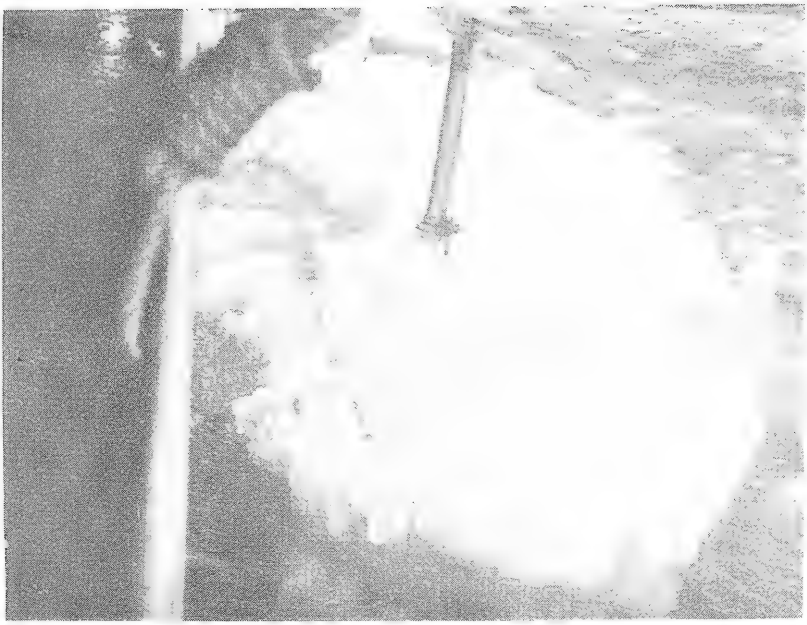


Figure 33—Honeycombed structure of an overturned **rotten block.**

Figure 34—**Rotten ice.** The melted edges of the ice are dark, as are the patches caused by the melting through of the ice by the sea water beneath. Polar bears are occasionally seen.

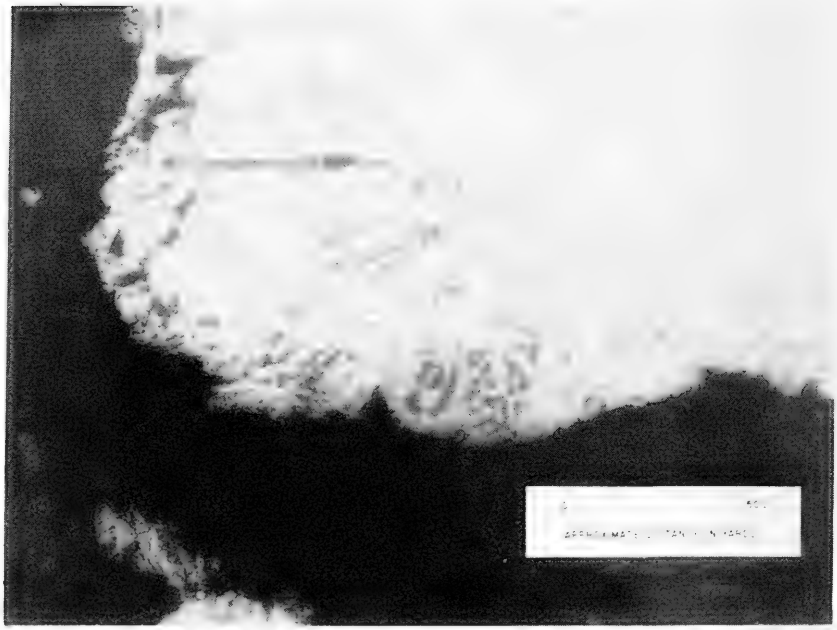


Figure 35—Aerial view of a portion of a **giant floe** composed of **rotten ice. Puddles** cover the surface of the **floe.** (U.S. Air Force.)

Figure 36—**Flat ice with crack** and frozen **puddles.**

Figure 37—**Flat ice** in a final stage prior to its disintegration. **Puddles** have partially melted through the ice.

Figure 38—Rafted ice.

Figure 39—**Rafted ice.** The **rafting** in this case was probably caused by the passage of a ship.

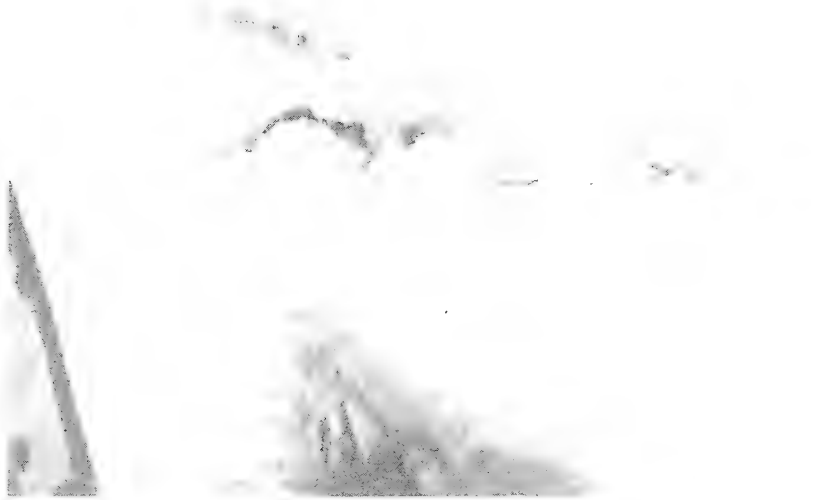


Figure 40—**Hummock.** A bluish glow beneath the ledges frequently may be observed.

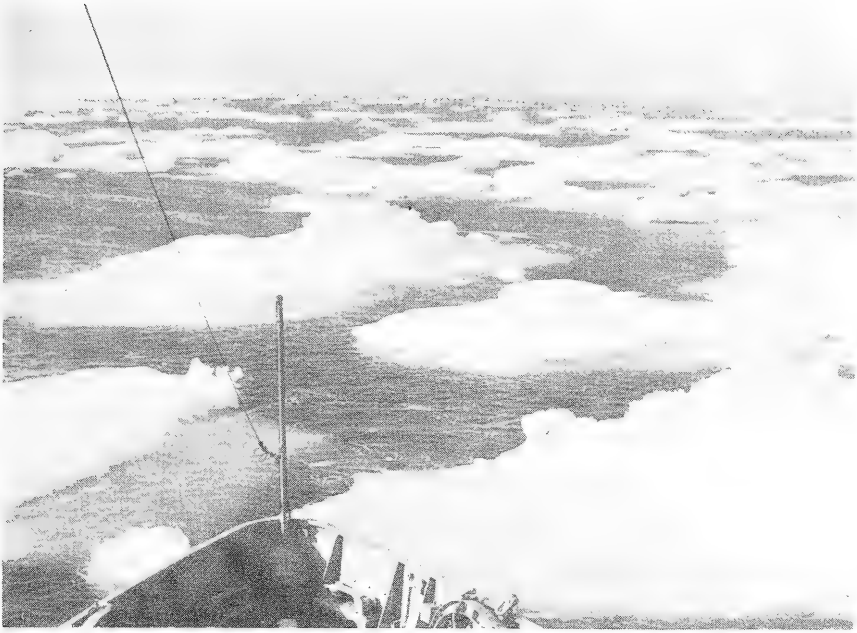


Figure 41—**Hummocky floes** that have **weathered.**

Figure 42—A **hummocky field** that has been subjected to **weathering** and puddling.

Figure 43—An **ice field** that has been **hummocked** and **weathered.** Probable **water sky** on the horizon.

Figure 44—**Hummock** that has been **weathered.**

Figure 45—Unweathered **pressure ridges.**

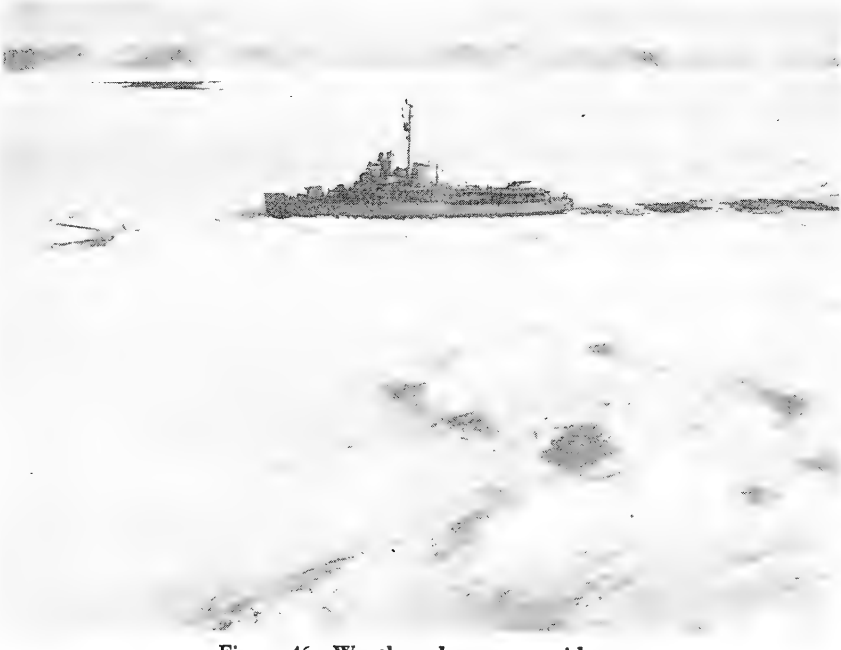


Figure 46—Weathered pressure ridges.

Figure 47—Aerial view of the **ice pack** showing a thick network of **pressure ridges.** The extreme height of these ridges is about 25 feet. (U.S. Air Force.)

Figure 48—Heavily **hummocked** and **rafted ice.** (Source unknown.)

Figure 49—Close-up of a **pressure ridge** on the **ice pack.**

Figure 50—Surface view of the **ice pack** showing **pressure ice.**

Figure 51—**Ropak.** (Gakkel, Laktionov, and Vize.)

Figure 52—**Floeberg.**

Figure 53—**Ice foot** with growth chiefly at the top. (Wright and Priestley.)

Figure 54—**Storm ice foot.** (Wright and Priestley.)

Figure 55—**Shore ice.** (Wright and Priestley.)

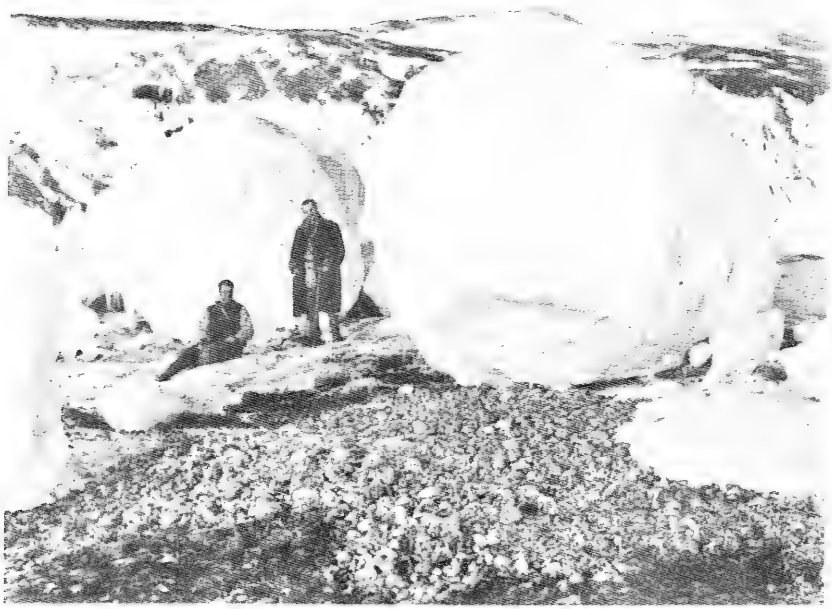


Figure 56—**Ice boulders.** (Wright and Priestley.)

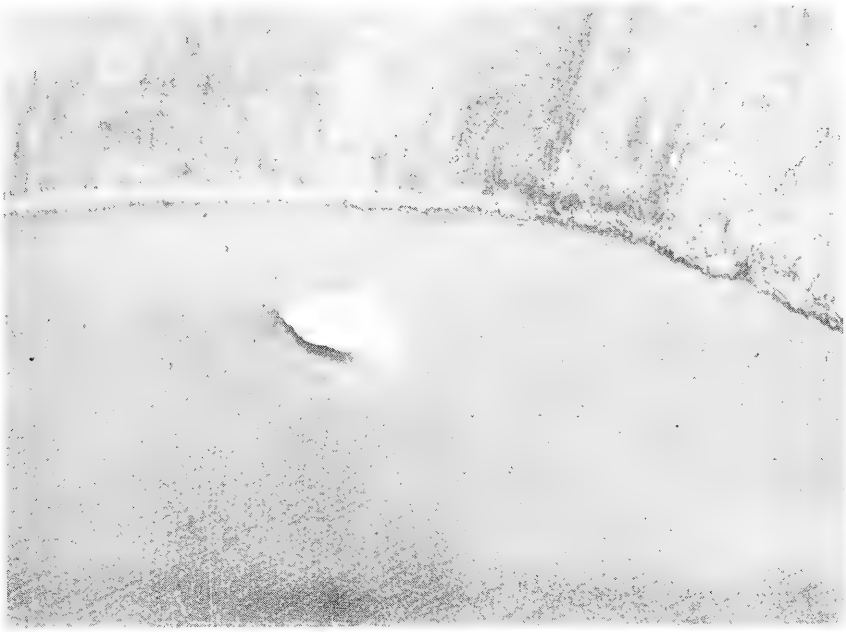


Figure 57—Aerial view of a **stamukha** with a **ram** projecting under water.

Figure 58—**Stamukha.**

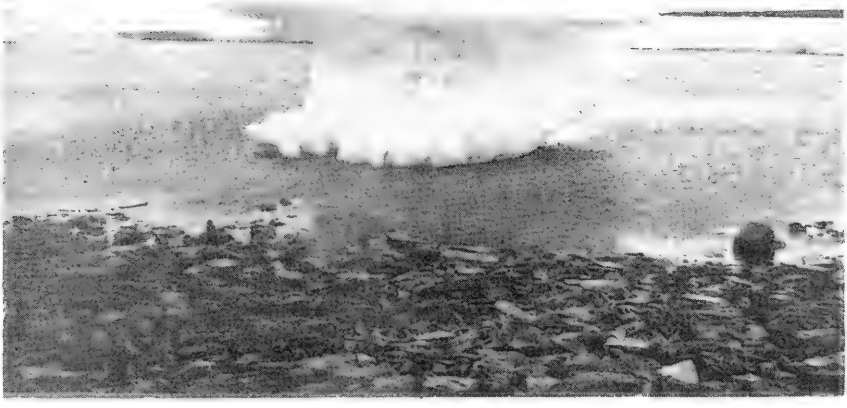


Figure 59—**Stamukha.**

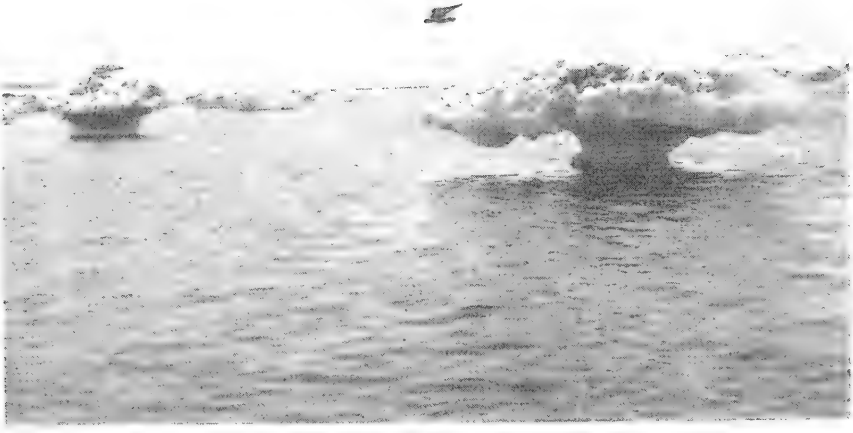


Figure 60—**Stamukhi** that have been eroded at the water line by the tide into a mushroom form.

Figure 61—**Flaw** between **fast ice** on the left and the **ice pack** on the right. The **ice pack** is moving to the right at 2 knots.

Figure 62—**Crack in flat ice with frozen puddles.**

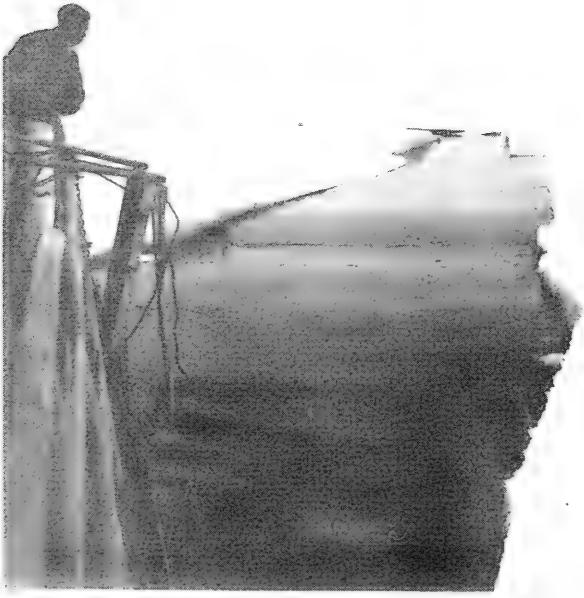


Figure 63—Close-up view of a **crack.**

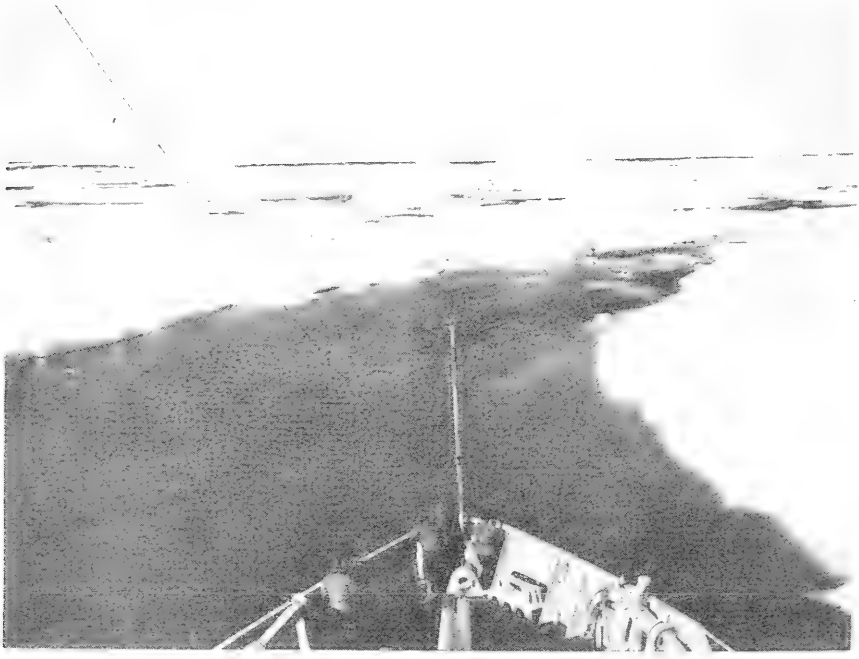


Figure 64—**Blind lead.**

Figure 65—**Lead** in a puddled **ice field.**

Figure 66—Polynya.

Figure 67—A mountain range almost submerged by antarctic **continental ice.** An ice-filled **cirque** has bitten deeply into the isolated **nunatak** on the right.

Figure 68—**Highland ice** in the background. **Small floes** and **brash** in the foreground. (Wright and Priestley.)

Figure 69—Terminal **lobe** of a **wall-sided glacier.** (Wright and Priestley.)

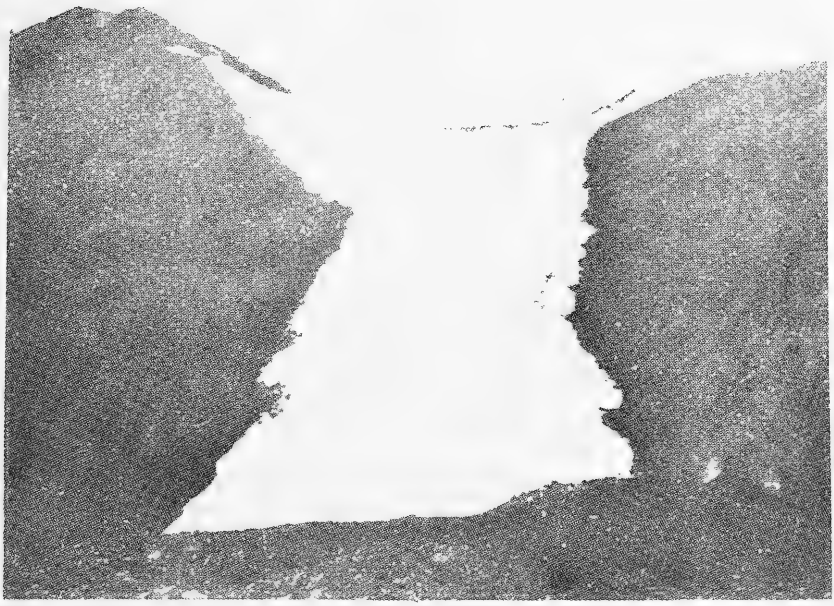


Figure 70—**Glacier** with **ice apron.** (Wright and Priestley.)

Figure 71—Two **valley glaciers** with **lateral moraines.** Both **glaciers** show **crevasses.**

Figure 72—**Valley glacier** with a series of **crevasses** near the terminus of the **glacier.** A few **growlers** dot the sea surface.

Figure 73—The seaward edge of an **outlet glacier. Calving** has produced many **bergy bits** and **growlers.** Lines of weakness are shown at the lower right.

Figure 74—Barnard Glacier, Alaska, showing relation of **lateral** and **medial moraines** to tributary **glaciers.** The high peak is Mt. Natazhat (13,480 feet), 25 miles away on the Alaska-Yukon boundary. (Bradford Washburn.)

Figure 75—**Expanded foot ice.**

Figure 76—**Ice tongue afloat.** There is extensive crevassing in the **glacier** at the steepening of its slope. (Wright and Priestley.)

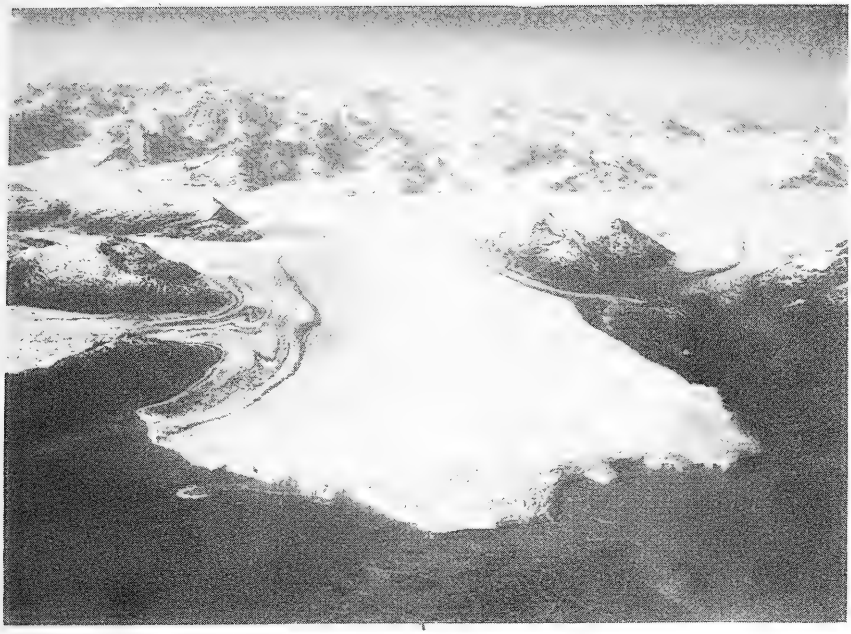


Figure 77—Columbia Glacier, a **piedmont glacier,** Prince William Sound, Alaska. **Calving** into tide water, the piedmont **lobe** is shrinking rapidly. (Bradford Washburn.)

Figure 78—**Ice cliff** formed from **shelf ice** on the right meeting the sea. On the left are **small floes, blocks,** and **brash. Calving** is in preparation along the **crevasse** at the right.

Figure 79—**Shelf ice.** The rift in the foreground is a frozen **lead** created after the parting of the **shelf ice.** The dark spots on the ice are seals. The undulations in the background were caused by compression of the ice.

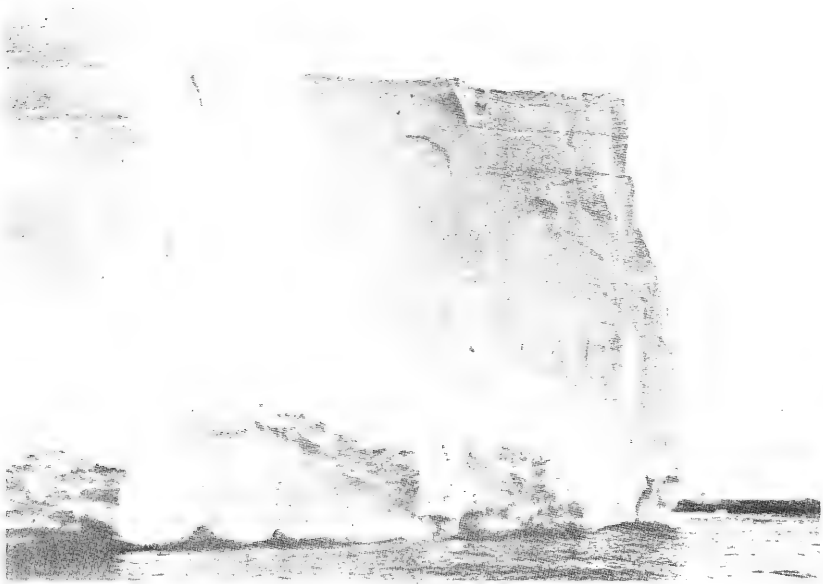


Figure 80—Cliff of **shelf ice.** Each strongly marked horizontal band represents a year's snowfall. (Mawson.)

Figure 81—**Ice cliffs.** A snow **cornice** overhangs the brow of the cliff in front of the figure. (Mawson.)

Figure 82—**Cornice** along an **ice cliff.** (Wright and Priestley.)

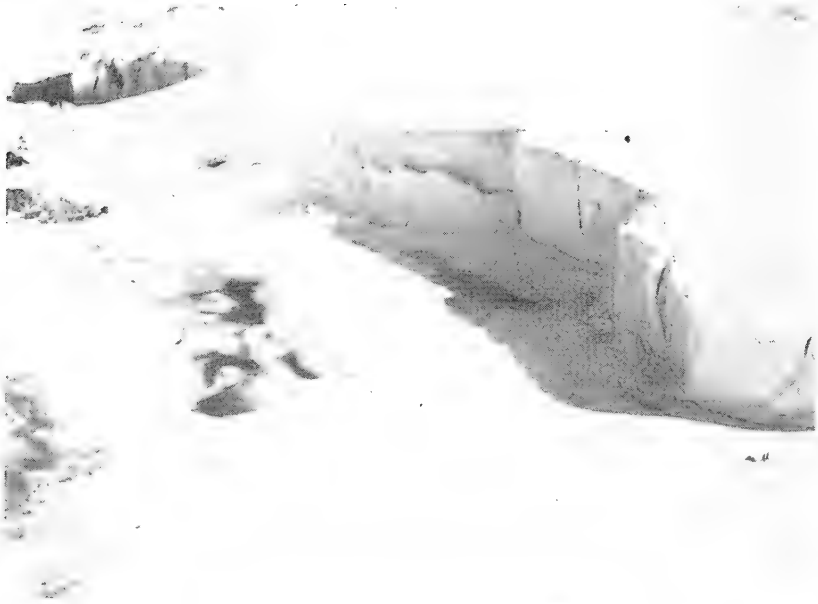


Figure 83—**Ramp** connecting **shelf ice** with **sea ice** to the left.

Figure 84—At the foot of a **ramp** beneath **ice cliffs.** (Mawson.)

Figure 85—**Ramp** between **sea ice** and **land ice.**

Figure 86—Calving of a fragment of a **glacier** to form an **iceberg.** (Wright and Priestley.)

Figure 87—**Pinnacled iceberg.**

Figure 88—**Pinnacled iceberg** surrounded by **small floes, blocks,** and **brash.**

Figure 89—**Arched iceberg** on the left, **valley iceberg** in the center.

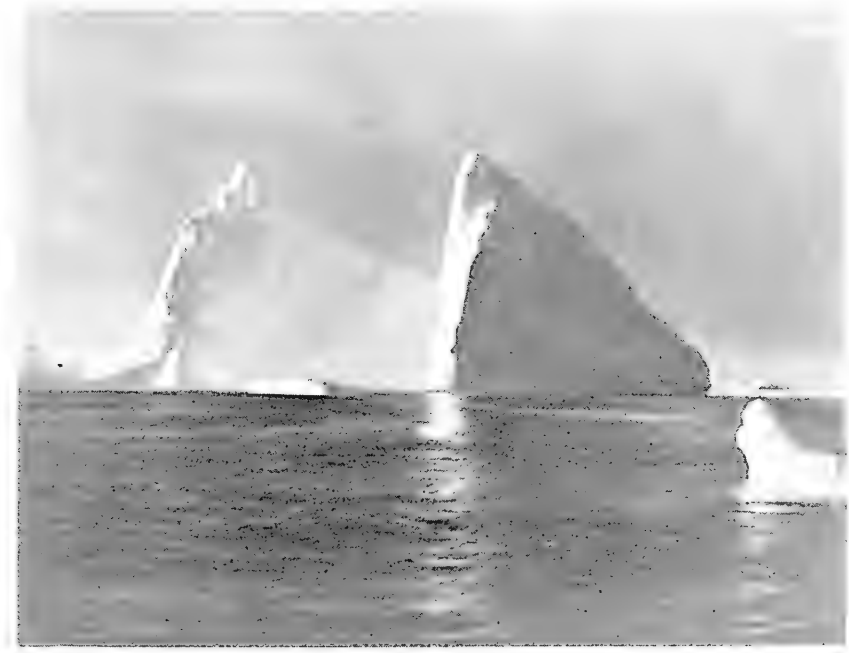


Figure 90—Valley iceberg.

Figure 91—**Blocky iceberg** to the left and **tilted iceberg** to the right.

Figure 92—**Pinnacled iceberg** whose rounded contours indicate **weathering.**

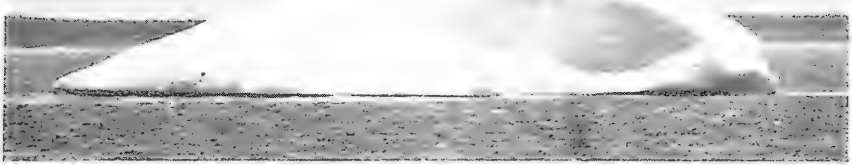


Figure 93—**Weathered iceberg.**

Figure 94—Small **tabular iceberg** with an arch.

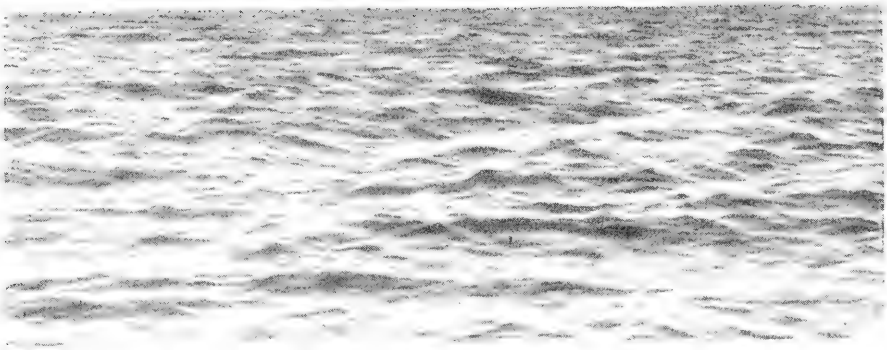


Figure 95—**Tabular iceberg.**

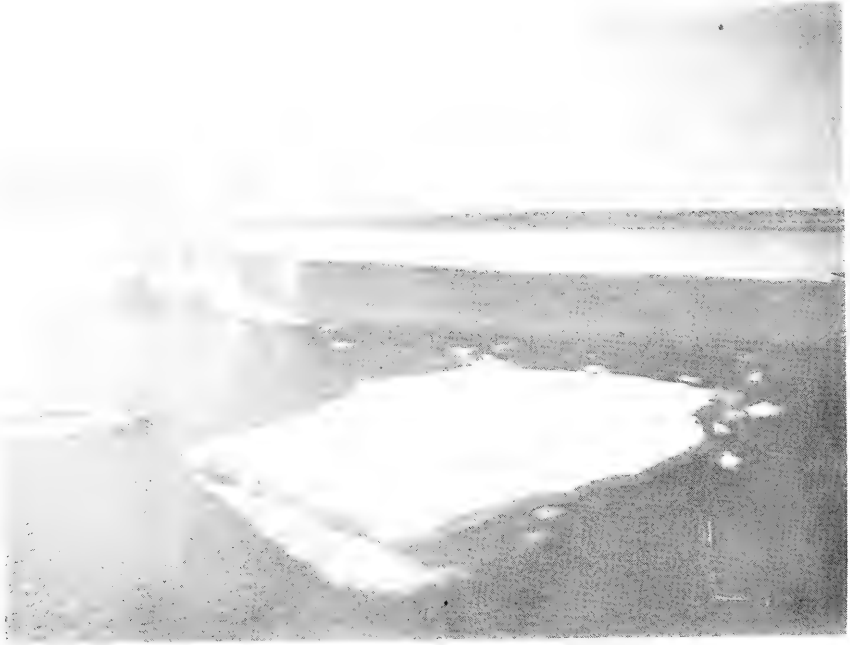


Figure 96—**Tabular iceberg** with a **medium floe** in the foreground. A **ram** projects under the water around the **floe.**

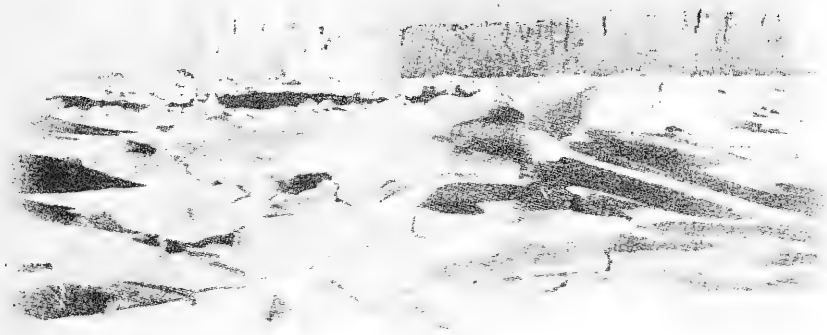


Figure 97—**Unconformity iceberg.** A prominent series of **crevasses** is confined to the lower strata only. (Wright and Priestley.)

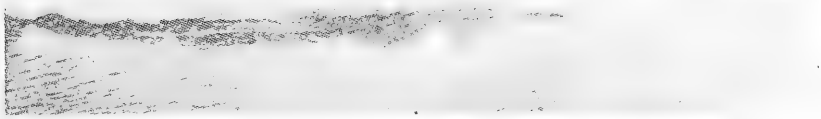


Figure 98—**Ice island iceberg** in background. (Wright and Priestley.)

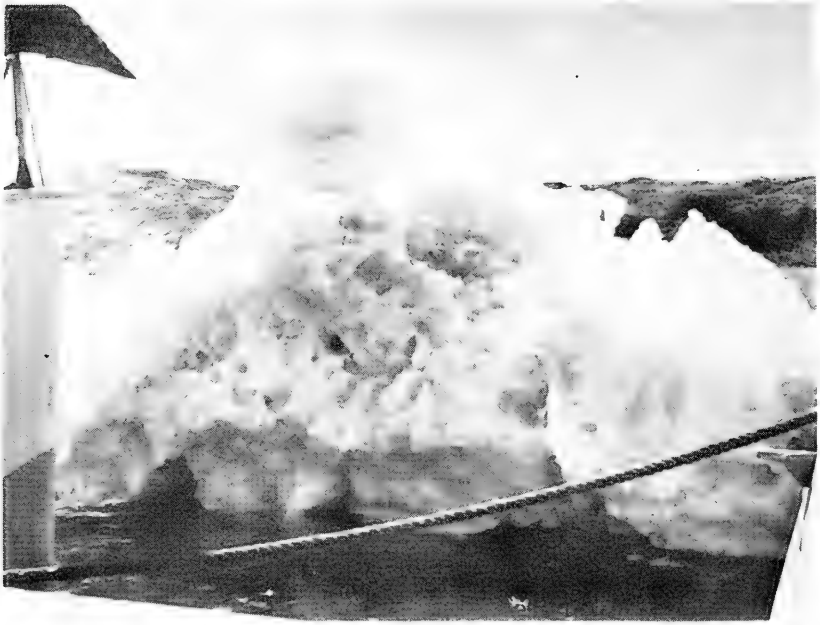


Figure 99—A stranded, overturned **bergy bit** showing honeycombed structure and fused glass texture. (U.S. Coast Guard.)

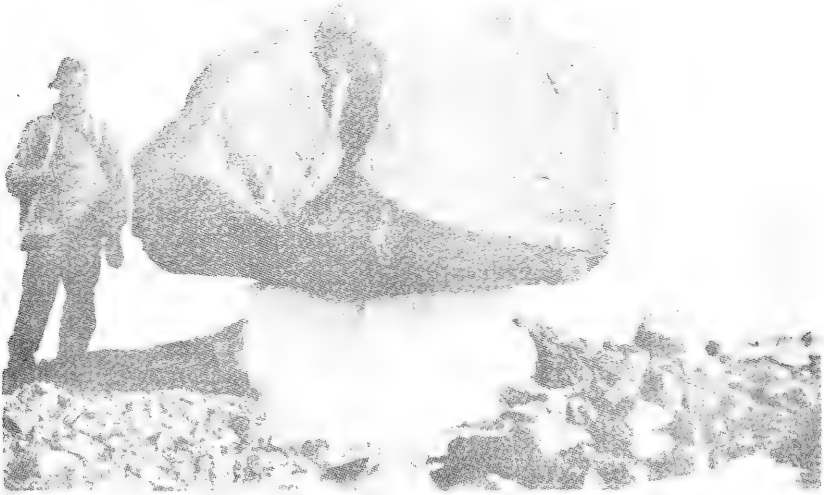


Figure 100—Ice pillar. (Wright and Priestley.)

Figure 101—Lake ice. Breakup season, spring of 1939, Mackinaw, Michigan. (U.S. Weather Bureau.)

Figure 102—River ice. The Coast Guard Cutter ACUSHNET assisting the MARSHALL B. HALL in the Hudson River near Kingston, N. Y., December 29, 1933. (International News.)

Figure 103—**Ice jam** in the Allegheny River, March 1926. The tracks were covered with about 4 feet of ice. (U.S. Weather Bureau.)

Figure 104—Ship **icing.** The lower parts of the superstructure are the most heavily iced. The spray was predominantly from about four points off the port bow. (U.S. Coast Guard.)

Figure 105—Ship icing. In the lee of the spray is the least amount of icing. The spray was predominantly from about four points off the port bow. (U.S. Coast Guard.)

Figure 106—**Frost smoke.** (Wright and Priestley.)

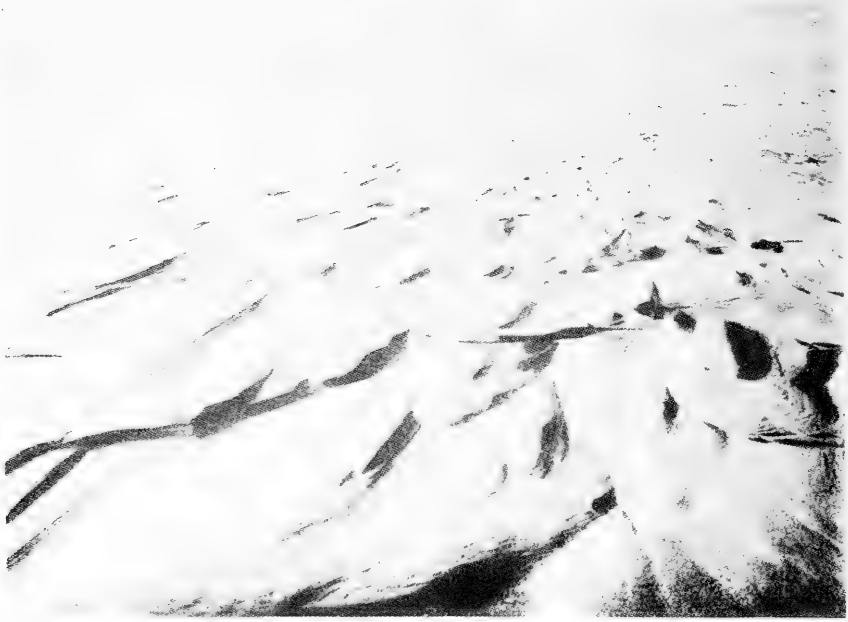


Figure 107—**Sastrugi,** looking upwind. (Wright and Priestley.)

Figure 108—**Ice storm** damage at Bolivar, Missouri, January 10, 1949. (Betty Love.)

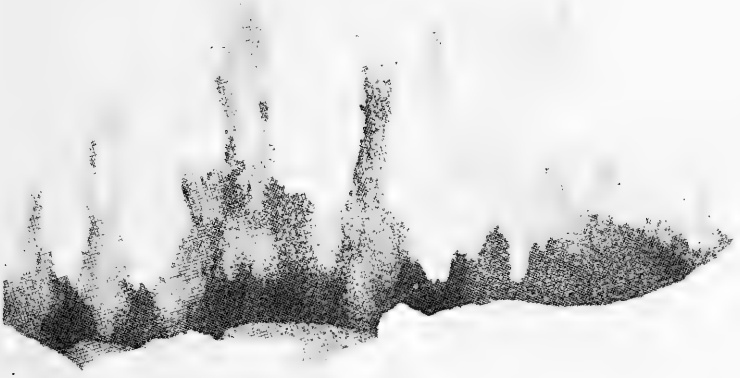


Figure 109—**Hoarfrost** deposited on **icicles.** (Wright and Priestley.)

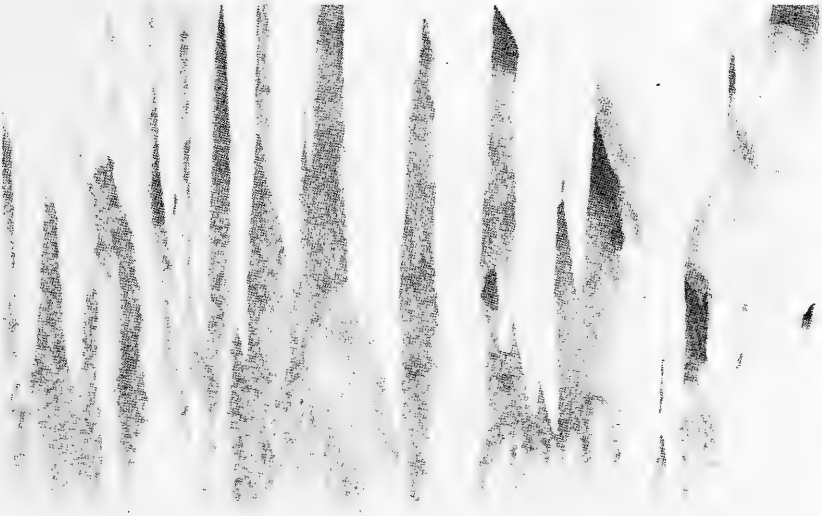


Figure 110—Icicles formed from freezing spray. (Wright and Priestley.)

BIBLIOGRAPHY

BLACK, R. F. "Permafrost," *Trask, P. D. (ed.) Applied Sedimentation; a Symposium.* pp. 247-275. N.Y.: J. Wiley, 1950.

FAY, A. H. *A Glossary of the Mining and Mineral Industry.* (U.S. Bureau of Mines, Bulletin 95) Washington: Government Printing Office, 1948.

FLINT, R. F. *Glacial Geology and the Pleistocene Epoch.* N.Y.: J. Wiley, 1947.

GERMANY, DEUTSCHES HYDROGRAPHISCHES INSTITUT. *Atlas der Eisverhältnisse des Nordatlantischen Ozeans und Übersichtskarten der Eisverhältnisse des Nord- und Südpolargebietes.* Hamburg: Deutsches Hydrographisches Institut, 1950.

GORDON, A. R., JR. and WOODWORTH, W. C. "Some Inter-Relationships of Snow and Ice Conditions and Weather in the Arctic," *American Meteorological Society, Bulletin,* vol. 31, pp. 271-278, 1950.

GREAT BRITAIN, HYDROGRAPHIC DEPARTMENT. *Arctic Pilot.* Fifth Edition. vol. 1, pp. 13-16. London: The Admiralty, 1947.

HOBBS, W. H. *Characteristics of Existing Glaciers.* N.Y.: Macmillan Company, 1911.

HOLMES, A. *Principles of Physical Geology.* pp. 205-252. N.Y.: Ronald Press, 1944.

INTERNATIONAL METEOROLOGICAL ORGANIZATION, COMMISSION ON MARITIME METEOROLOGY, SUBCOMMISSION III, "Ice Nomenclature," (Circular Letter, SCIII/1, Appendix) January 1949. Unpublished.

JENNESS, J. L. "Permafrost in Canada," *Arctic,* vol. 2, pp. 13-27, 1949.

JOYCE, J. R. F. "Notes on Ice Foot Development, Neny Fjord, Graham Land, Antarctica," *Journal of Geology,* vol. 58, pp. 646-649, 1950.

KERRY, J. G. G. "Winter Navigation on the St. Lawrence," *Dock and Harbour Authority,* vol. 31, pp. 219-225, 1950.

KOCH, L. *The East Greenland Ice.* (Meddelelser om Grønland, Bd. 130, nr. 3) Copenhagen: Reitzel, 1945.

KOLCHAK, A. "The Arctic Pack and the Polynya," *Problems of Polar Research.* pp. 125-141. N.Y.: American Geographical Society, 1928.

KUENEN, P. H. *Marine Geology.* pp. 25-27. N.Y.: J. Wiley, 1950.

LAKE, P. *Physical Geography.* Second Edition Revised. pp. 345-362. Cambridge: University Press, 1949.

LONGWELL, C. R., KNOPF, A., and FLINT, R. F. *A Textbook of Geology. Pt. I, Physical Geology.* Second Revised Edition. N.Y.: J. Wiley, 1939.

MATTHES, F. E. "Glaciers," *Meinzer, O. E. (ed.) Hydrology.* (Physics of the Earth—IX) pp. 149-219. N.Y.: Dover Publications, 1949.

MAURSTAD, A. *Atlas of Sea Ice.* (Geofysiske publikasjoner, Vol. 10, No. 11) Oslo: I Kommisjon hos Cammermeyers Boghandel, 1935.

MAWSON, D. *The Home of the Blizzard.* 2 vols. Philadelphia: J. B. Lippincott, 1914.

ROBERTS, B. "Shelf Ice, a Note on Terminology," *Journal of Glaciology,* vol, 1, pp. 413-415, 1950.

"Sea Ice; Terminology, Formation and Movement," *The Polar Record*, vol. 4, pp. 126-133, 1943.

SHELESNYAK, M. C. *Across the Top of the World.* (NAVEXOS P-489) Washington: U.S. Navy, Office of Naval Research, August, 1947.

SELIGMAN, G. *Snow Structure and Ski Fields.* London: Macmillan Company, 1936.

SMITH, E. H. "Ice in the Sea," *National Research Council, Division of Physical Sciences. Oceanography.* (Physics of the Earth—V) pp. 384-408. Washington: The Council, 1932.

STEFANSSON, V. *Arctic Manual.* N.Y.: Macmillan Company, 1944.

TARR, R. S. and MARTIN, L. *College Physiography.* N.Y.: Macmillan Company, 1918.

TRANSEHE, N. A. "The Ice Cover of the Arctic Sea, with a Genetic Classification of Sea Ice," *Problems of Polar Research.* pp. 91-123. N.Y.: American Geographical Society, 1929.

U.S., HYDROGRAPHIC OFFICE. *A Functional Glossary of Ice Terminology; (Provisional 5-48)* (H.O. Study 103) Washington: 1948.

——— *Sailing Directions for Antarctica.* (H.O. Pub. 138) pp. 21-24. Washington: 1943.

U.S., WEATHER BUREAU. *Weather Glossary*, compiled by A.H. Thiessen. (W.B. 1445) Washington: 1946.

VON ENGELN, O. D. *Geomorphology.* N.Y.: Macmillan Company, 1942.

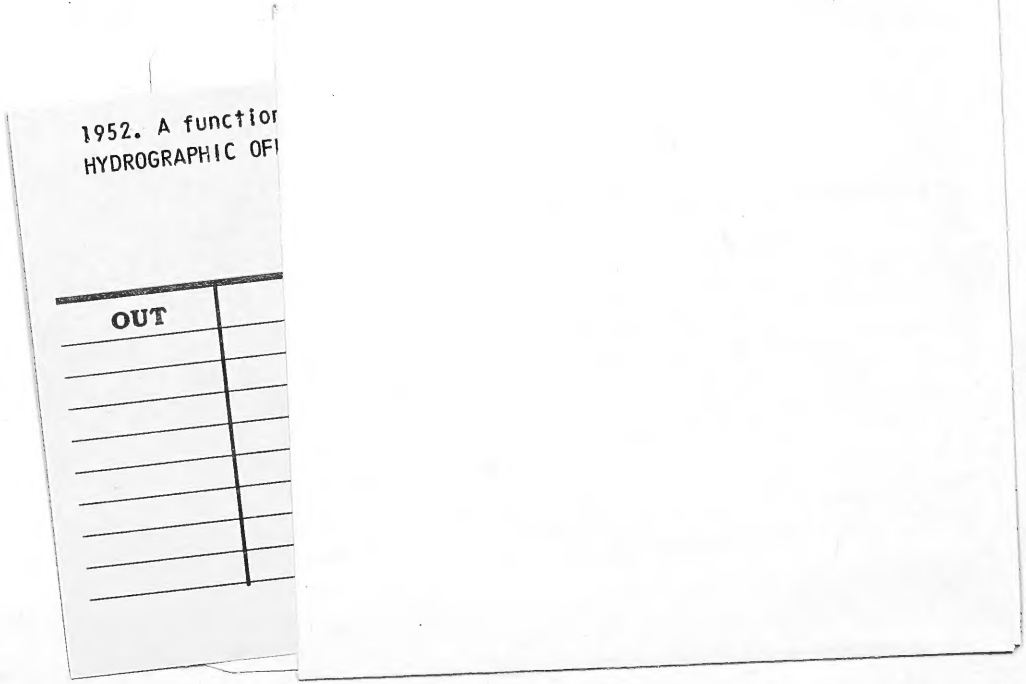
WELCH, P. S. *Limnology.* N.Y.: McGraw-Hill Book Company, 1935.

WRIGHT, C. S. and PRIESTLEY, R. E. *Glaciology.* London: Harrison and Sons, 1922.

WRIGHT, W. B. *The Quaternary Ice Age.* London: Macmillan Company, 1937.

ZEUSLER, F. A. "Standing Iceberg Guard in the North Atlantic," *National Geographic Magazine*, vol. 50, pp. 1-28, 1926.

☆ U. S. GOVERNMENT PRINTING OFFICE: 1952—955934


1952. A functior
HYDROGRAPHIC OFI
OUT